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ABSTRACT

The Stationary Engineering Laboratory Manual 2 was designed for vocational/technical high school students who have received instruction in the basics of stationary engineering. It was developed for students who will be operating a live plant and who will be responsible for supplying steam for heating, cooking, and baking. Each lesson in the manual lists behavioral objectives, needed apparatus, procedures, and assignments. The major units are: engineering fundamentals, steam boilers, boiler fittings, boiler room systems, feed-water accessories, steam accessories, fuels, combustion accessories, combustion, boiler plant instruments, boiler water conditioning, compressed air system, electrical, operation, and service and maintenance. (NJ)

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STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL EDUCATION

STATIONARY ENGINEERING

LABORATORY MANUAL-2

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State of New Jersey
Department of Education
Division of Vocational Education

STATIONARY ENGINEERING
LABORATORY MANUAL - 2

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March 1976

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INTRODUCTION TO THE ENGINEERING DEPARTMENT STUDENTS

Now that you have decided to enter the Stationary Engineering Program, the next two years will be spent acquiring the skills and knowledge needed to enter industry and successfully compete. You and you alone are responsible for your future. Industry needs workers who have the knowledge, skill, self discipline, and pride in a job well done.

The engineering instructors will continue to stress safety, neatness, and accuracy. You must learn to accept responsibility. Take pride in yourself and the plant that you will be learning to maintain and operate.

You will be introduced to the fireman's responsibilities and duties. You will also learn how to better handle the tools of your trade.

It is important that you keep in mind that you are operating a live plant. We are responsible for supplying steam for heating, cooking, and baking. We also supply steam for our air conditioning and hot water systems. Our plant must always operate; we cannot shut down.

The engineering instructors hope that this will be a profitable and a pleasant year. Please remember that we are here to help you; we cannot do it for you.

ASSIGNMENT 1–A–1

Title: Shop Safety

Objectives:

1. Be able to recognize all shop safety rules.
2. Be able to correctly report an accident.

Apparatus:

1. List of shop safety rules
2. Accident report forms
3. Safety glasses

Procedure:

1. Read over list of Shop Safety Rules.
2. Check over accident report form and be familiar with reasons for immediate filling.
3. Check and adjust safety glass assigned to you.

Assignment:

1. Can you explain why shop safety rules must be followed?
2. Take list of shop safety rules home, discuss them with your parents. Have them signed and return to your instructor.
3. Why do you feel wearing safety glasses is a good idea?
4. Fill out an Accident Report form. Assume that your hand was burned by steam. Make up the rest of the details as you think the accident might have happened.

ASSIGNMENT 1–A–2

Title: Handling Fire Fighting Equipment

Objective:

1. Be able to use water, CO_2 and foam extinguishers to put out a fire.

Apparatus:

1. One water extinguisher
2. One CO_2 extinguisher
3. One large mason's mixing tub
4. One foam extinguisher
5. One gallon of gasoline

Procedure:

1. Students will first examine three fire extinguishers and be familiar with how to operate each.
2. Instructor will set up masonry tub with 3-4 inches of water and pour one gallon of gas on top of water.
3. Instructor will start fire and show how each extinguisher is used. Students will observe results of each extinguisher on fire.
4. Instructor will start a new fire and each student will use a fire extinguisher to put out fire.

Assignment:

1. Following the procedure above, students will use fire extinguishers to put out fire.
2. What was the effect of the water extinguisher on the gas fire?
3. Which fire extinguisher did you find easiest to use?

Note: This unit will be done in an open area behind school with engineering instructor present. He will start all fires.

ASSIGNMENT 1–A–3

Title: Housekeeping (Painting)

Objectives:

1. Be able to properly mix paint and prepare area for painting.
2. Be able to paint lines, boilers, or auxiliaries in boiler room as assigned.
3. Be able to properly clean and store brushes and paint cans after painting.

Apparatus:

1. Paint
2. Brushes
3. Cleaning bucket
4. Drop cloths

Procedure:

1. Inspect area assigned to you to make sure it has been cleaned. There should be no signs of oil, grease, or dirt of any kind.
2. Sign out brushes of proper size, size will depend on area assigned.
3. Sign out proper color paint.
4. Use paint stirrer and thoroughly mix paint.
5. Open paint can being careful not to damage can or cover.
6. Use drop cloths to protect surrounding area.
7. Paint area assigned being careful to avoid runs.
8. Clean all paint brushes everyday. With oil base paints, clean in varsol and then soap and water. With acrylic or rubber base paints, use soap and water.
9. Clean paint can rim and close can lids tightly. Do not damage covers.
10. Have instructor inspect area assigned, paint brushes, and paint cans for a daily grade.

Assignment:

1. Follow procedure outlined above and paint area assigned to you.

ASSIGNMENT 1–B–1

Title: Shop Organization and Management

Objectives:

1. To know student's responsibilities
2. To know student's responsibility in tool crib.
3. To know student's responsibility when acting as fireman.
4. To know student's responsibility when acting as engineer.

Apparatus:

1. Student's responsibilities
2. Tool crib procedure
3. Student firemen responsibility

Procedure:

1. Review student responsibility.
2. Study tool crib procedure sheet.
3. Study fireman's duties.
4. Study engineer's duties as presented in class.

Assignment:

Be prepared to carry out your duties when assigned to tool crib, fireman watch, or engineers watch. Remember your responsibility when assigned to these duties.

ASSIGNMENT 2–A–1–1

Student's Responsibilities

1. Observe all shop safety rules at all times.
2. Report to shop on time and with clean work clothes.
3. Handle all tools and equipment with respect.
4. Clean and return tools and equipment to their proper locations after use.
5. Place oil rags in their proper container.
6. Complete all safety check-out lists before using power equipment.
7. Immediately report any accident to the instructor.
8. Complete all assignments using good engineering standards of safety, accuracy, neatness, and thoroughness.
9. Report any unsafe conditions observed to the instructor. Safety is everyone's responsibility.
10. Treat your fellow students with the respect you yourself wish to receive.

Conduct yourself at all times in a manner that will bring credit to yourself, your school, and our engineering department. Any discredit is a reflection not only on yourself, but on the department as a whole. We are very proud of our past graduates. They have been accepted in industry with all the dignity and rights of the stationary fireman and engineer. It is your responsibility to live up to their deeds and accomplishments – *You can do nothing less – you can only do more!*

ASSIGNMENT 2–A–1–2

Tool Crib Procedure

1. Student assigned to tool crib will get keys from instructor in charge. Check all tools and report any missing tools at once.
2. All tools or equipment will be issued only after receiving tool equipment request slip.
3. Tool-equipment request slips will be filed and returned only upon return of tool or equipment issued.
4. Tool crib man will not allow anyone other than instructor in charge to enter crib area.
5. He will be responsible for keeping all equipment and tools in working condition – Examples:
   a. Sharpen drill bits
   b. Sharpen chisels
   c. Repair all drop lights
   d. Check plugs on all drills
   e. Replace damaged hammer handles
   f. Check chisels for mushroomed heads
   g. Check blades on screw drivers
6. He will report to engineering instructor at end of shop period any tools or equipment outstanding and who signed them out.
7. The tool crib man will not leave tool crib unattended for any reason.
8. He will be responsible for locking up and returning tool crib keys.

ASSIGNMENT 2–A–1–3

Student Fireman's Responsibility

Students assigned as firemen will be responsible for the following:

Report to Boiler Room in work clothes on time and take over watch following procedure outlined below:

1. Check water level on all boilers on line by blowing down gage glass and water column.
2. Blow down feed-water regulator and low-water cut-off.
3. Check steam pressure and condition of fires.
4. Check all running auxiliaries for proper temperature, pressure, and lubrication.
5. Check log for any orders on previous shift.

He will report to instructor in charge anything he feels is out of order. Then he will proceed with fireman's normal duties:

1. Change over and clean fuel oil strainers.
2. Clean burner tip on boiler on line.
3. Test safety valves.
4. Keep constant check on all operating equipment for proper running conditions.
5. Check blow-down control air compressor tank.
6. Assist watch engineer with getting water samples, boiler blow down or any other duties assigned.

The fireman on watch will not leave the floor plates for any reason unless properly relieved.

He will be responsible for leaving the boiler room area in clean condition for the next shift.

ASSIGNMENT 2–B–1

Title: Factor of Evaporation

Objective:

1. Be able to calculate the factor or evaporation of a boiler.

Apparatus:

Boilers that are in service

Procedure:

1. From your related science lessons you will recall that you find the factor of evaporation of any boiler with the following formula:

$$\text{Fact. of Evap.} = \frac{H_s - (F.W. - 32)}{970.3}$$

H_s = B.T.U. content per pound of steam leaving the boiler.

F.W. = Temperature in degrees Farenheit of the feed water as it enters the boiler.

2. Assuming the quality of the steam is 100% from each boiler, determine from the steam tables the B.T.U. content of the steam leaving each boiler.
3. Read and record the temperature of the feed water before it enters each boiler.
4. With the data from 2 and 3 above, calculate the factor of evaporation of each boiler.

Assignment:

1. Complete attached chart and be prepared to discuss your results with the engineering instructor.

FACTOR OF EVAPORATION CHART

	H_s	F.W.	FACT. OF EVAP.
BOILER 1			
BOILER 2			
BOILER 3			
BOILER 4			
BOILER 5			

$$\text{FACT. OF EVAP.} = \frac{H_s - (FW - 32)}{970.3}$$

H_s = HEAT OF STEAM B.T.U.

F.W. = FEED WATER TEMP.

970.3 = LATENT HEAT OF EVAPORATION

32° = HEAT BASE OF FAHRENHEIT SCALE

NOTE ALL CALCULATIONS SHALL BE ATTACHED TO THIS CHART.

2-B-1-1

ASSIGNMENT 2–B–2

Title: Developed Boiler Horsepower

Objective:

1. Be able to calculate the developed horsepower of a boiler.

Apparatus:

Boilers in service
Steam flow meter

Procedure:

1. From your related science lessons, you will recall that the definition of a boiler horsepower is "the evaporation of 34.5 pounds of water from and at 212°F." To find developed boiler horsepower, you used the following formula:

$$\text{Developed boiler H.P.} = \frac{W \times \text{fact. of evap.}}{34.5}$$

W = Pounds of steam produced per hour

2. In all calculations for developed horsepower, you will use the factor of evaporation that you learned to calculate in unit 2–B–1.
3. From the data on the safety valves of each boiler, calculate the maximum horsepower that can be developed.
4. Calculate the boiler horsepower being developed using the steam flow meter.
5. The old method of calculating boiler horsepower was to find the total square feet of heating surface and divide by ten.

$$\text{BPH or boiler horsepower} = \frac{\text{Heating Surface}}{10}$$

From data stamped on the boiler shell, calculate the boiler horsepower of each boiler.

Assignment:

1. Complete the attached chart and be prepared to discuss it with the engineering instructor.

BOILER HORSEPOWER

BOILER	FACT. OF EVAP.	Wsv	HP	Wfm	HP	HS	HP
1							
2							
3							
4							
5							

$$HP = \frac{W \times \text{FACT. OF EVAP}}{34.5}$$

Wsv = POUNDS PER HOUR ON SAFETY VALVE

Wfm = POUNDS PER HOUR ON FLOW METER

HS = HEATING SURFACE

NOTE: ALL CALCULATIONS ARE TO BE ATTACHED TO THIS CHART.

2-B-2-1

ASSIGNMENT 2–C–3

Title: Saturated and Superheated Steam

Objectives:

1. Be able to discuss the pressure-temperature relationship that exists for saturated steam.
2. Be able to determine if steam is saturated or superheated.
3. Be able to use the steam tables.

Apparatus:

Boilers that are in service
One pyrometer
Steam pressure reducing station

Procedure:

1. Use the attached chart to record all pressures and temperatures.
2. With the pyrometer, take the temperature of the water and the steam of the high-pressure boiler.
3. Take note of and record pressure on the high-pressure boiler.
4. Repeat the above procedure on the low-pressure boiler and record.
5. Take the temperature of the steam after it has passed from the high- to the medium-pressure header. Record pressure and temperature.
6. Take the temperature and pressure of the steam after it passes from the medium- to the low-pressure headers and record.

Assignment:

1. Complete the attached chart using the steam tables to find the temperatures of the saturated steam at the various pressures.
2. Be prepared to discuss the following with your instructor
   a. Do the steam pressure and temperature correspond? If not why?
   b. Was the steam saturated or superheated?
   c. If the steam is superheated, to what degree is it superheated?

PRESSURE – TEMPERATURE

BOILER NO.	STEAM PRESSURE	STEAM TEMPERATURE	WATER TEMPERATURE	TEMP. FROM STEAM TABLE
MEDIUM PRESSURE HEADER				
LOW PRESSURE HEADER				

2-C-3-1

ASSIGNMENT 3–A–2

Title: Types of Firetube Boilers

Objective:

1. Be able to identify the various types of firetube boilers and the important features of each type.

Apparatus:

Firetube boilers
Boiler data sheets

Procedure:

1. Examine each steam boiler carefully and take note of the following:
   a. Shape of boiler
   b. Number of gas passes
   c. Internally or externally fired
   d. Shape of combustion space
   e. Up-take damper location

2. From the boiler data sheets, match each boiler with its type.

Assignment:

1. Complete the attached chart and be prepared to discuss the information with the engineering instructor.
2. Sketch one of the firetube boilers

FIRETUBE BOILER TYPES

BOILER NO.	BOILER SHAPE	NO. OF GAS PASSES	INTERNAL OR EXTERNAL FIRED	UPTAKE DAMPER LOCATION	BOILER TYPE
1					
2					
3					
4					
5					

ASSIGNMENT 3–A–3

Title: Construction of Firetube Boilers

Objective:

1. Be able to identify the external and internal parts of a firetube boiler.

Apparatus:

Firetube boilers

Procedure:

1. Examine the following external parts of each boiler:
   a. Hand-holes
   b. Man-holes
   c. Water legs
   d. Stay bolts – note difference between high- and low-pressure boilers.
2. Examine the following internal boiler parts on all boilers that are open:
   a. Fire tubes
   b. Tube sheet
   c. Stays
   d. Crown sheet
3. Measure the diameter and the length of the fire tubes on a boiler that is off the line. Count the number of tubes.
4. Measure the depth of the telltale on the stay bolts.

Assignment:

1. Complete the attached chart and be prepared to discuss your data and information.
2. Label the location of the following on the drawing that you sketched from 3–A–2:
   a. Handholes
   b. Manholes
   c. Water legs
   d. Stay bolts
   e. Tubes
   f. Tube sheet
   g. Stays
   h. Crown sheet

FIRE TUBE BOILER CONSTRUCTION

BOILER NO.	NO. OF HANDHOLES	NO. OF MANHOLES	WATER LEGS	STAY BOLTS WITH HOLES	STAY BOLTS NO HOLES	CROWN SHEET	LENGTH OF TUBES	DIA. OF TUBES
1								
2								
3								
4								
5								

NOTE UNDER STAYBOLT WITH HOLES INCLUDE DEPTH OF TELLTALE HOLE.
UNDER LENGTH OF TUBES INCLUDE NUMBER OF TUBES.

3-A-3-1

ASSIGNMENT 3–C–1

Title: Boiler Certificates

Objective:

1. Be able to list the information on a boiler certificate.

Apparatus:

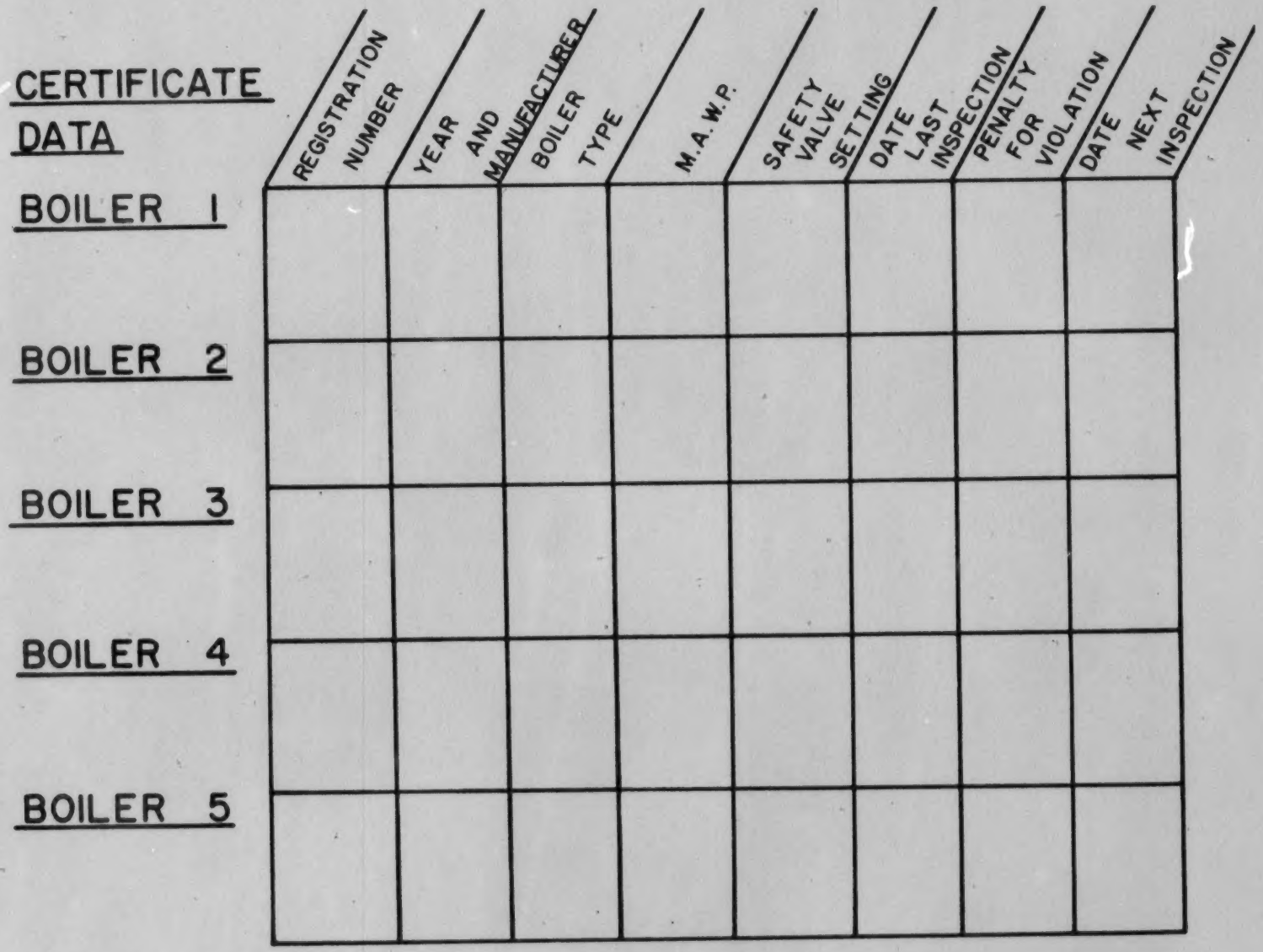
Steam boilers
Boiler certificates

Procedure:

1. Examine the boiler certificate for each boiler.
2. Take note of the following data on each certificate:
   a. Registration numbers
   b. Make of boiler and year built
   c. Type
   d. Maximum allowable working pressure
   e. Safety valve setting
   f. Date of last inspection
   g. Penalty for violation
3. Examine the data on each boiler safety valve to see if it corresponds with what is on the certificate.
4. Examine each boiler for manufacturers stampings and check if they correspond.
5. Check boiler fronts for posting of boiler numbers.

Assignment:

1. Complete attached charts and be prepared to discuss data with instructor.


CERTIFICATE DATA
REGISTRATION NUMBER
YEAR AND MANUFACTURER
BOILER TYPE
M.A.W.P.
SAFETY VALVE SETTING
DATE LAST INSPECTION
PENALTY FOR VIOLATION
DATE NEXT INSPECTION
BOILER 1
BOILER 2
BOILER 3
BOILER 4
BOILER 5

3-C-1-1

ASSIGNMENT 4–A–2

Title: Safety Valves (Construction)

Objective:

1. Be able to take a safety valve apart and explain how it is constructed.

Apparatus:

1. Pop-type safety valve
2. Tools necessary for dismantling safety valve

Procedure:

1. Examine cut-away of safety valve.
2. Dismantle valve making note of all parts.
3. Measure diameter of valve when seated.
4. Measure diameter of valve when open.
5. Notify instructor and be prepared to identify parts of safety valve.
6. Reassemble valve.

Assignment:

1. List the parts of a safety valve and the purpose of each part.
2. Using the measurements of valve open and closed, find the following:
   a. area of valve seat when closed
   b. area of valve seat when open
3. If steam pressure on seat of valve were 100 PSI, find:
   a. total force on valve seat when closed.
   b. total force on valve seat when opened.
   c. Increase of total force due to huddling chamber.
4. Sketch and label pop-type safety valve.

ASSIGNMENT 4–B–2

Title: Construction of Bottom Blow-Down Valves

Objectives:

1. Be able to dismantle a quick-closing and screw-type blowdown valve.
2. Be familiar with the parts of a quick-closing and screw-type blow-down valve.

Apparatus:

1. Quick-closing valve
2. Screw-type valve
3. Tools needed to dismantle valve
4. Manufacturers data sheet

Procedure:

1. Examine cut-away model of quick-closing and screw-type valve.
2. Dismantle and identify parts of both valves.
3. Take special note of which valve is closest to shell of boiler.
4. Examine screw-type valve carefully so that you can explain why it can't trap sludge.
5. Call instructor and be prepared to identify all parts and explain operation.
6. Reassemble valve.

Assignment:

1. Follow procedure listed above, take valves apart, and identify parts.
2. Sketch and label parts of both valves.
3. Explain why you feel sludge could not build up in the screw type valve.

ASSIGNMENT 4–C–1

Title: Construction of Water Column

Objectives:

1. Be able to identify the fittings found on a water column.
2. Be able to explain the purpose of each fitting.

Apparatus:

1. Two models of a water column
2. Manufacturers Data Sheets
3. Tools for dismantling column

Procedure:

1. Examine models of both water columns.
2. Make list of all fittings attached and the purpose that they serve.
3. Remove all fittings (except whistle valve) from column and examine internally.
4. Examine floats and make note of how they attached to whistle valve.
5. Remove whistle valve.
6. Call instructor and be prepared to identify all parts and describe the purpose they serve.
7. Reassemble water column.

Assignment:

1. Follow procedure outlined above.
2. After examining column and gage glass, do you feel it is necessary to blow down the column and glass once a shift. Explain.

ASSIGNMENT 4–C–2

Title: Location of Water Columns According to A.S.M.E. Code

Objective:

1. Be able to check the proper location of a water column according to A.S.M.E. Code.

Apparatus:

1. 6' Folding Rule
2. Any boiler that is off the line
3. A.S.M.E. Code Section I

Procedure:

1. Check Related Science Manual or A.S.M.E. Code for location.
2. Use any boiler that is off line for cleaning or inspection.
3. Get clearance from instructor in charge and add water to boiler or drop water depending on conditions until it just shows in bottom of gage glass.
4. With manhole cover off, use rule and measure amount of water over highest heating surface.
5. Record and check against A.S.M.E. Code.
6. Notify instructor and be prepared to discuss your findings.

Assignment:

1. Follow procedure outlined above.
2. What did A.S.M.E. Code state about location of gage glass?
3. What does gage glass location have to do with water column location?

Note: Check with instructor in charge as to where he wants boiler water level left.

ASSIGNMENT 4–D–1

Title: Using Test Gages

Objectives:

1. Be able to use a test gage.
2. Be able to check a pressure gage using a test gage.

Apparatus:

1. Test gages
2. 6" Adjustable
3. Small Stillson wrench
4. Boilers on line

Procedure:

1. Sign out test gage and tools needed.
2. Handle test gage carefully.
3. Connect test gage to a low pressure boiler on line.
   Note: Check for siphon protection.
4. Compare readings and record on chart provided.
5. Connect test gage to a high pressure boiler on line.
6. Compare readings and record on chart provided.
7. Calculate percentage error if any.
8. Return gage and tools.

Assignment:

1. Follow procedure outlined above.
2. Notify instructor and have him check your work.

PRESSURE GAGE CORRECTION CHART

BOILER USED	BOILER PRESSURE	TEST GAGE PRESSURE	% OF ERROR	FAST OR SLOW

$$\% \text{ ERROR} = \frac{\text{ERROR}}{\text{ACTUAL READING}} \times 100$$

NOTE: ALL CALCULATIONS MUST BE ATTACHED TO CHART

ASSIGNMENT 4–D–2

Title: Dead Weight Tester

Objectives:

1. Be able to handle a gage tester.
2. Be able to calibrate a pressure gage using a dead weight tester.

Apparatus:

1. Dead weight tester
2. 3 pressure gages
3. 6″ adjustable wrench
4. Instruction sheet on dead weight tester

Procedure:

1. Sign out equipment needed.
2. Read instruction sheet on dead weight tester.
3. Set up gage on test block and record your reading on chart provided.
4. Notify instructor when you have finished and be prepared to demonstrate how you got your readings.

Assignment:

1. Follow procedure outlined above.
2. Before setting up gage on tester, notify instructor and explain how you will proceed with your testing.
3. Record all readings on chart provided and be prepared to defend your findings.

PRESSURE GAGE CALCULATIONS

		RANGE	WEIGHT	READING	ERROR	% ERROR
GAGE	1					
	A					
	B					
	C					
	D					
	E					

GAGE	2					
	A					
	B					
	C					
	D					
	E					

GAGE	3					
	A					
	B					
	C					
	D					
	E					

NOTE: ATTACH ALL CALCULATIONS TO CHART 4-D-2-1

ASSIGNMENT 5–A–1

Title: High-Pressure Feed-Water System

Objectives:

1. Be able to locate the high-pressure feed-water lines.
2. Be able to locate every valve, fitting, and control on the high-pressure feed-water line.
3. Be able to determine every possible way of getting water to the high-pressure boilers.

Apparatus:

Feed-water system

Procedure:

1. You know from your related science classes the importance of water in a boiler. The loss of water in a boiler that is on the line could cause serious damage or a possible boiler explosion.
2. It is necessary that the engineer and the fireman of a plant know all the feed-water lines, valves, and fittings and also be familiar with every possible way of getting water to the boiler.
3. Trace all high-pressure feed-water lines from the feed-water source to each high-pressure boiler. Take careful note of all valves and fittings.
4. Make a rough sketch of each line labeling all valves and fittings.

Assignment:

1. Sketch and label as indicated below showing direction of flow:
   a. Boiler No. 2 – starting from feed-water heater and using reciprocating feed-water pump.
   b. Boiler No. 2 – starting from the condensate return tank.
   c. Boiler No. 5 – starting from feed-water heater using the centrifugal pump
   d. Boiler No. 5 – starting from the condensate tank.

   This will mean four completed sketches.
2. Be prepared to explain and discuss all parts of the feed-water system with the instructor.

ASSIGNMENT 5–A–2

Title: Low-Pressure Feed-Water System

Objectives:

1. Be able to locate the low-pressure feed-water lines.
2. Be able to locate every valve, fitting and control on the low-pressure feed-water line.
3. Be able to determine every possible way of getting water to the low-pressure boiler.

Apparatus:

Feed-water system

Procedure:

1. The loss of water is as serious in a low-pressure boiler as it is in a high-pressure one, and it can lead to the same results – damage to or loss of the boiler. It is important to know every part of the low-pressure feed-water system.
2. Trace all low-pressure feed-water lines from their source to each low-pressure boiler. Take note of all valves and fittings.

Assignment:

1. Sketch, label and indicate direction of flow of feed-water to the boilers listed below:
   a. Boiler No. 1 – from low vacuum tank
   b. Boiler No. 1 – from condensate return tank
   c. Boiler No. 3 – from high-condensate return tank
   d. Boiler No. 3 – from high-vacuum tank
   e. Boiler No. 4 – from gravity-feed water tank
   f. Boiler No. 4 – from condensate return tank

   This will mean six completed sketches.
2. Be prepared to explain and discuss all parts of the low-pressure feed-water system with the instructor.

ASSIGNMENT 5–B–1

Title: Fuel Oil System

Objective:

1. Be able to locate the lines, fittings, pumps, valves, and accessories that make up the fuel oil system.

Apparatus:

No. 6 fuel oil system

Procedure:

1. Trace the fuel oil system starting at the Duplex fuel oil strainers and ending at the line returning to the tank.
2. Take note of and examine each fitting, pump, valve, and accessory in the system when possible.
3. Make a rough sketch of the fuel oil system. Label each part and show direction of the flow of oil.

Note: All fittings, pumps, valves and accessories must be included.

ASSIGNMENT 5–B–2

Title: Fuel Oil Tank Soundings

Objectives:

1. Be able to take a fuel oil sounding.
2. Be able to read a fuel oil tank calibration chart.
3. Be able to calculate daily fuel oil consumption.

Apparatus:

Sounding rod
Tank calibration chart
Key to tank
Varsol and Rags

Procedure:

1. Using the sounding rod, sound No. 1 and No.2 fuel oil tanks.
2. Record the readings from each tank.
3. From your readings, determine how much oil is in the tanks by using the fuel oil tank calibration charts.
4. Record the amount of fuel oil in each tank.
5. Find the total amount of fuel oil by adding No. 1 and No. 2 tank readings in gallons.
6. Calculate the day's consumption by subtracting today's total amount from yesterday's total.
7. Record the day's consumption on the daily fuel oil log sheet.

Assignment:

1. While acting as fireman or assistant fireman, take soundings on No. 1 and No. 2 fuel oil tanks.
2. Record your readings.
3. Calculate and record the daily fuel oil consumption on the log provided.
4. Repeat the above assignment for five days.

ASSIGNMENT 5–B–3

Title: High- and Low-Pressure Gas Systems

Objective:

1. Be able to locate the parts of the high-pressure system.
2. Be able to locate the parts of the low-pressure gas system.

Apparatus:

Numbers 3, 4, and 5 gas burner systems.

Procedure:

1. Trace the high-pressure gas line from where it enters the boilerroom until it enters No. 3 boiler.
2. Trace the high-pressure gas line from where it enters the boilerroom until it enters No. 4 boiler.
3. Trace the low-pressure gas line from where it enters the boilerroom until it enters No. 5 boiler.
4. Take note of all parts that make up each gas system.
5. Make a rough sketch of each gas system going to the boilers above. Label all parts.

Assignment:

1. Make a finished line drawing of the gas system on No. 3 boiler.
2. Make a finished line drawing of the gas system on No. 5 boiler.
3. Make a finished line drawing of the gas system on No. 4 boiler.
4. Label all parts on each drawing and indicate the direction of flow.

ASSIGNMENT 5–C–1

Title: Draft System

Objectives:

1. Be able to explain the basic draft system in a boiler room.
2. Be able to locate the forced and induced draft fans.
3. Be able to locate all draft control dampers.
4. Be able to locate all draft gage lines on a boiler.

Apparatus:

Boilers
Forced and induced draft fans
Dampers

Procedure:

1. Trace the path the gases take from the furnace to the stack on each boiler.
2. Take note of fans, dampers, and draft gage line connections.
3. Make a rough sketch showing the gas path through each boiler to the stack. Include fans, dampers, and draft gage connections.
4. Trace draft gage connection lines from each boiler back to the main panel board.

Assignment:

1. Make a finished drawing of the gas flow through each boiler to the stack. Show the location of fans, dampers, and draft gage line connections. Label and indicate direction of flow.
2. Complete attached chart and be prepared to discuss it with the instructor.

DRAFT SYSTEM

BOILER NO.	NO. OF PASSES	NATURAL DRAFT	FORCED DRAFT	INDUCED DRAFT	BALANCED DRAFT	UPTAKE CONNECTION	FURNACE CONNECTION
1							
2							
3							
4							
5							

ASSIGNMENT 6–A–2

Title: Feed Stop and Checks

Objectives:

1. Be able to disassemble a feed-stop and a feed-check valve.
2. Be able to identify the parts of a feed-stop and a feed-check valve.

Apparatus:

1. Globe valve
2. Swing check
3. Tools needed to dismantle valves
4. Manufacturers catalogs

Procedure:

1. Sign out valves and tools.
2. Dismantle stop valve, lay parts out on bench, and identify all parts.
3. Take special note of flow through valve.
4. Dismantle check valve, lay parts out on bench, identify all parts.
5. Take special note on operation of check valve.
6. Notify instructor and be prepared to identify parts of both valves, and be able to explain the reasons for their being installed the way they are.

Assignment:

1. Follow procedure outlined above.
2. Why must pressure from boiler be on top of valve seat?
3. Why is the pressure stamped on valve body?
4. What is the pressure stamping on our high-pressure boilers?

ASSIGNMENT 6–A–3

Title: Gasket Selection and Measurement

Objectives:

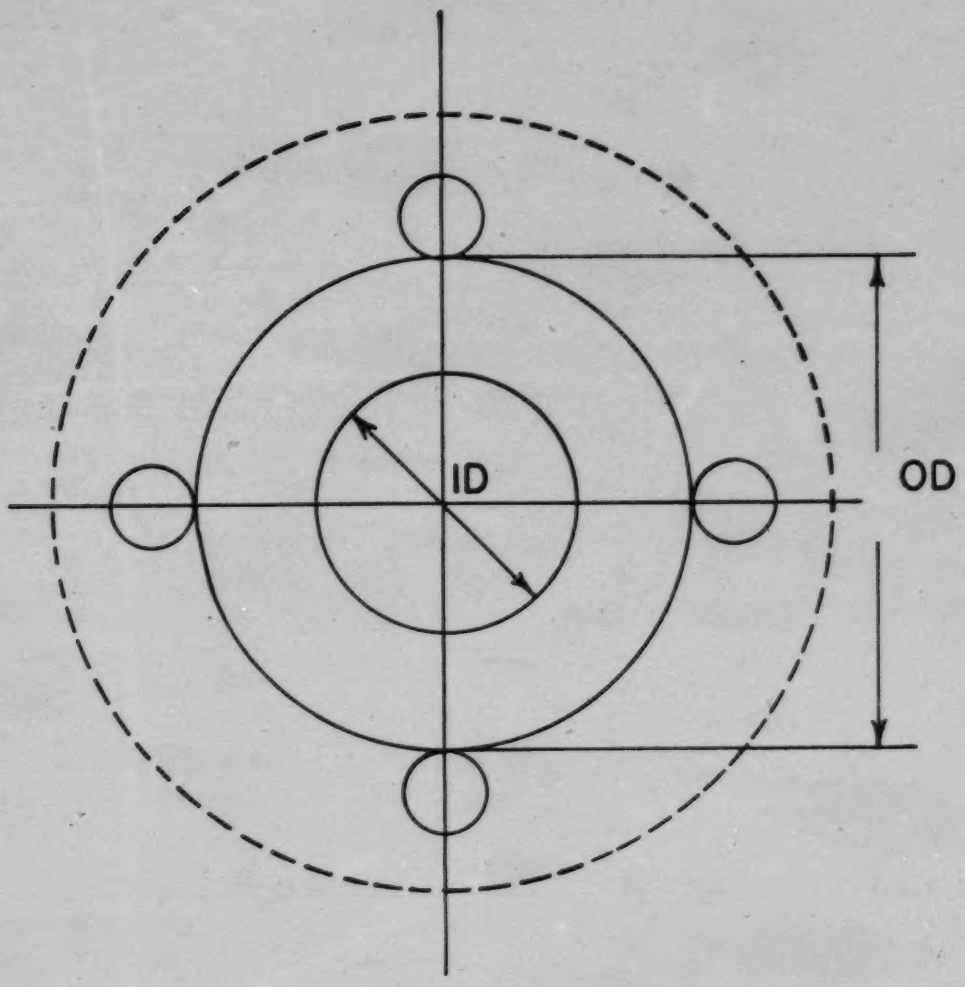
1. Be able to identify the different types of gasket materials and the service they are used for.
2. Be able to take measurements for making a ring gasket.
3. Be able to take measurements for making a full gasket.

Apparatus:

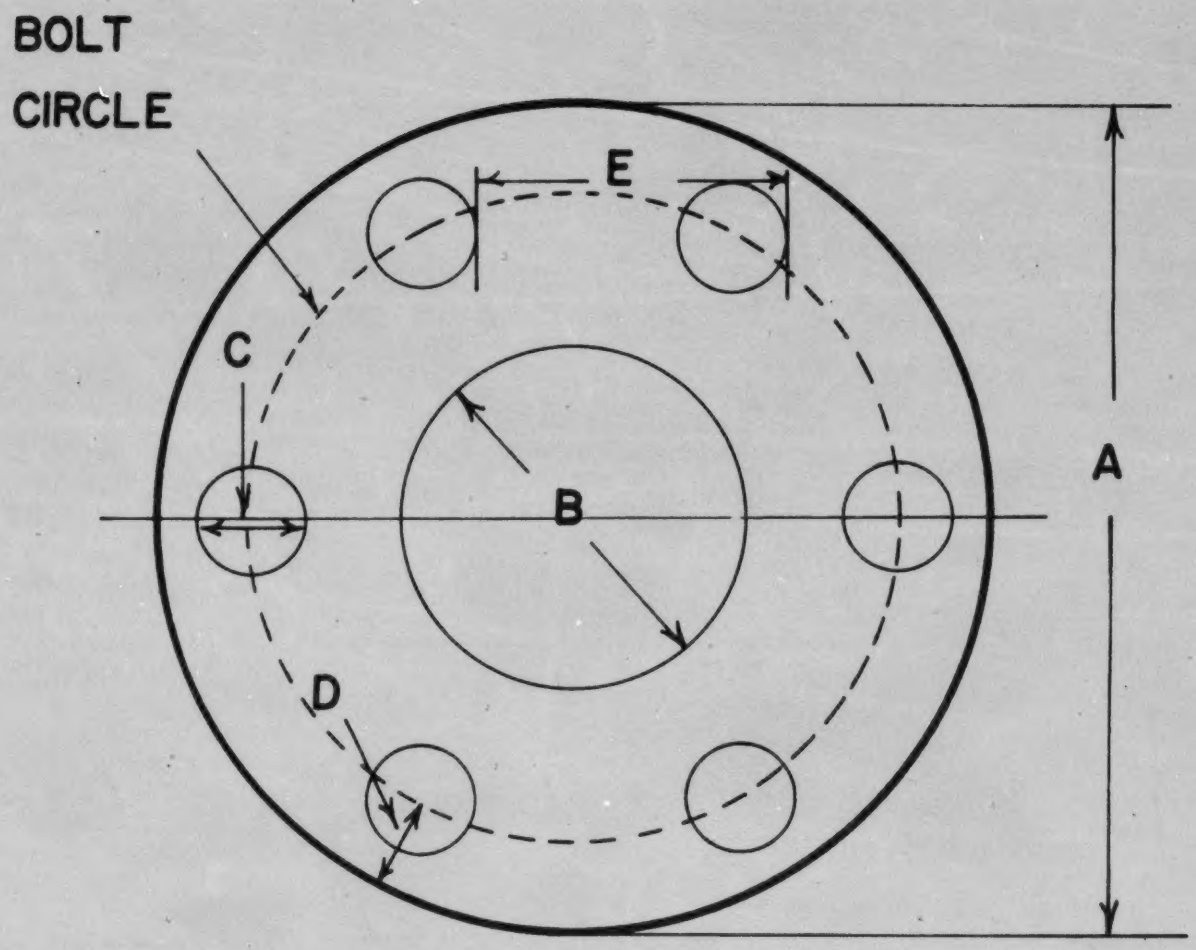
1. Assorted gasket material
2. Manufacturers catalog
3. Compass
4. Inside and outside calipers
5. Rule
6. Two pieces of poster board 12" x 12"
7. Flange

Procedure:

1. Sign out equipment needed.
2. Using manufacturers catalog, identify assorted gasket materials, and the service they are used for.
3. Using flange assigned, proceed to take measurements for a ring gasket as follows: (Sketch 6–A–3–1)
   a. Using inside calipers, measure inside diameter of flange. Record this dimension as ID.
   b. Using inside caliper, measure inside diameter of bolt holes. Record this dimension as OD.
   c. Using compass and poster board, scribe a ring gasket with the dimensions recorded.
4. Using flange assigned, proceed to take measurements for a full gasket as follows: (Sketch 6–A–3–2)
   a. Using outside calipers, measure and record outside dia.(A) and inside dia. (B) of flange.
   b. Using inside calipers, measure and record the size of bolt holes (C)
   c. Find bolt circle by measuring from outside edge of flange to center of bolt hole (D).
   d. To find distance between bolt hole centers, measure from outer edge of one bolt hole to inner edge of adjacent bolt hole (E).
   e. Using compass and poster board, scribe a circle using OD (A) of flange.
   f. Using the same center, scribe a circle using ID (B).
   g. To find diameter of the bolt circle, multiply measurement (D) by 2 and subtract from OD (A).
   h. Using this measurement and the same center, scribe bolt circle.
   i. Set compass to distance (E) and starting at any point on bolt circle, scribe an arch across bolt circle. Continue around using each point of intersection as a center. The points of intersection are the bolt hole centers.



RING GASKET MEASUREMENTS



FULL GASKET MEASUREMENTS

ASSIGNMENT 6–B–1

Title: Open Feed-Water Heater

Objectives:

1. Be able to identify the parts of an open feed-water heater and the purpose they serve.
2. Be able to trace the path of steam, water, oxygen, and other non-condensible gases.

Apparatus:

1. Open feed-water heater in boilerroom.

Procedure:

1. This assignment can only be done when the open feed-water heater has been taken out of service for its annual cleaning.
2. When heater has been opened examine it internally.
3. List all parts and the purpose they serve.
4. Trace the flow of steam, condensate, city water makeup, internal overflow, and suction line to pump.
5. Find out how oxygen and other non-condensible gases are vented.
6. Be prepared to explain to instructor how heater works.

Assignment:

1. Follow the procedure outlined above, and make a straight line sketch including all parts of open feed-water heater.

ASSIGNMENT 6–C–1

Title: Feed-Water Regulator

Objectives:

1. Be able to identify the internal parts of both a mechanical and electrical feed-water regulator.
2. Be able to describe how both a mechanical and electrical feed-water regulator work.

Apparatus:

1. Cut-away model of a McDonnel Miller regulator.
2. Cut-away model of a Copes regulator.
3. Manufacturers data sheets
4. Electric meter

Procedure:

1. Student will take one regulator at a time and with manufacturers data sheets identify all parts.
2. Using the meter and the electric regulator, note the operation of the control when the float is moved.
3. Carefully examine inclined tube and note how movement of tube can cause valve to open.

Assignment:

1. After becoming familiar with the parts and operation of both regulators, notify instructor and be prepared to identify parts and operation.
2. How does the action of the Copes regulator affect the operation of a feed-water pump?

ASSIGNMENT 6–C–2

Title: Low Water Cutoff

Objectives:

1. Be able to identify the internal parts of a low water cutoff.
2. Be able to describe how the low water cutoff operates.

Apparatus:

1. Cut-away of low water cutoff.
2. Cut-away of combination low water cutoff and feed-water regulator.
3. Manufacturers data sheets
4. Electric meter

Procedure:

1. Student will examine cut-away of a low-water cutoff and identify all parts using manufacturers data sheets.
2. Student will connect electric meter and note operation of regulator when float is moved.
3. Student will examine combination low-water cutoff and feed- water regulator.
4. Student will connect electric meter and note operation when float is moved.
5. Student will identify pump control side and low-water cutoff side of regulator.

Assignment:

1. Follow procedure outlined above.
2. When you are finished, notify instructor in charge and be prepared to identify parts and discuss operation of the controls.
3. Do you think it important to blow down a low-water cutoff daily? Explain your answer.
4. How many ways can a low-water cutoff be tested? Explain how this is done.

ASSIGNMENT 6–C–3

Title: Gasket Cutting

Objectives:

1. Be able to use a gasket cutter.
2. Be able to follow the procedure in cutting a gasket.

Apparatus:

1. Gasket cutter kit
2. Cutting board
3. Sheet packing
4. Rule
5. 1 piece 12" x 12" poster board

Procedure:

1. Examine gasket cutter and attachments without blade being inserted.
2. Set cutter for 2" radius, then have instructor check it. Set it for 4 5/8" radius, and have it checked.
3. Instructor will assign you a gasket to cut. Take all necessary measurements and cut it first on poster board.
4. After instructor has checked it out, proceed to cut gasket using gasket material.
   Note: Blade on cutter should be set to just a little below depth of packing. Never leave cutter with blade extending if you have to leave secure blade.

Assignment:

1. Follow procedure outlined above.
2. Have instructor check all your work before using gasket material.
3. After cutting your gasket, tag it for the service it is to be used for and turn in to instructor for grading and filing on the gasket board.

ASSIGNMENT 6–D–1

Title: Atmospheric Return

Objectives:

1. Be able to locate the condensate tank in a system.
2. Be able to identify all the lines going to and leaving the condensate tank.
3. To know why an automatic city water make-up is used on condensate tanks and how they work.

Apparatus:

1. Condensate return tank in boiler room

Proecdure:

1. Student will examine condensate return tank, identify all fittings and trace all lines coming to and leaving tank.
2. Student will observe action of automatic city water make-up.
3. Student will sketch condensate tank, label all its parts, and indicate all lines as to where they came from and where they are going.

Assignment:

1. Follow procedure outlined above. Finished sketch will be turned in to instructor. Be prepared to identify all lines and fittings.

ASSIGNMENT 6–D–2

Title: Vacuum Tank

Objectives:

1. Be able to locate the vacuum tank in a system and describe how it works.
2. Be able to use pump selector switch when needed.
3. Be able to recognize and correct faulty operation.
4. Be able to identify all the fittings found on a vacuum tank and the purpose they serve.

Apparatus:

1. Vacuum tank in boilerroom
2. Manufacturers catalog

Procedure:

1. Examine the vacuum tank and identify all its parts and know the purpose they serve. Use manufacturers catalog for help.
2. Trace all lines coming to and leaving the vacuum tank and be able to identify their point of origin and destination.
3. Work selector switch and note operation of pump.
4. Operate float switch and note operation of pump.
5. Make sketch of vacuum tank and pump, labeling all parts.
6. Notify instructor and be prepared to discuss pump operation and all parts.

Assignment:

1. Follow procedure outlined above and turn in finished sketch.

ASSIGNMENT 6–E–1

Title: Reciprocating Pumps

Objectives:

1. Be able to completely strip down a reciprocating pump.
2. Be able to thoroughly clean steam and water side of a reciprocating pump.
3. Be able to reassemble and set the valves on a reciprocating pump.

Apparatus:

1. Reciprocating pump
2. Manufacturers data sheet
3. Tools needed to dismantle pump

Procedure:

1. You will be assigned a pump to strip, clean, and reassemble.
2. Examine pump and then sign out tools needed.
3. Mark all parts before any dismantling is attempted.
4. Notify instructor and have him check all markings.
5. Completely strip the pump and thoroughly clean all parts. Have instructor check out all cleaned parts.
6. Reassemble pump and set valves.
7. Hook up air lines to pump; then notify instructor. You and your instructor will test run pump together.

Assignment:

1. Follow procedure outlined above.
2. Describe step by step procedure followed in dismantling pump.
3. Show by sketch the steps taken in placing pump in mid-position.
4. Be prepared to discuss how you set pump valves.

ASSIGNMENT 6–E–2

Title: Centrifugal Pump

Objective:

1. Be able to completely strip down a centrifugal pump.
2. Be able to describe the purpose of all internal parts.
3. Be able to reassemble pump and check for free rotation.

Apparatus:

1. Centrifugal pump
2. Manufacturers catalogs
3. Tools needed for dismantling

Procedure:

1. You will be assigned a pump to strip, clean, and reassemble.
2. Examine pump and sign out necessary tools.
3. Mark all parts before starting to dismantle pump. Notify instructor and point out all markings.
4. Completely strip pump; then clean and lay out all parts on bench.
5. Identify all parts and be prepared to discuss their purposes with instructor.
6. Reassemble pump making sure it is rotating freely when finished.

Assignment:

1. Follow procedure outlined above.
2. Have instructor check all markings before stripping pump.
3. Be prepared to identify all parts of the pump and the purpose they serve.
4. What can be used in place of packing?

ASSIGNMENT 6-E-3

Title: Injector

Objectives:

1. Be able to locate and describe the purpose of a feed-water injector.
2. Be able to trace lines coming to and leaving the injector, and know the purpose of all valves of these lines.
3. Be able to completely strip an injector, clean it, and reassemble it ready for service.

Apparatus:

1. Injector in boilerroom
2. Manufacturers data sheet

Procedure:

1. Trace all lines going to and leaving the injector.
2. Make a rough sketch labeling all lines and valves.
3. Notify instructor when ready and explain how he would secure injector in order to work on it.
4. Examine injector and sign out necessary tools.
5. Remove injector from line; dismantle, clean thoroughly, and lay out all parts.
6. Notify instructor and explain parts and how the injector works.
7. Reassemble injector and put it back on line ready for service.

Assignment:

1. Follow procedure outlined above.
2. Submit finished sketch showing all valves and lines.

ASSIGNMENT 7–A–1

Title: Steam to Water Cycle

Objective:

1. Be able to sketch and explain the steam to water cycle.
2. Be able to describe how condensate returns to the system.
3. Be able to explain why it is important to save condensate.

Apparatus:

Boiler
Steam lines
Domestic hot water tank
Vacuum return system

Procedure:

1. Trace steam line from the boiler that is on the line to the low-pressure header.
2. From the steam header, trace the steam line to the domestic hot water tank.
3. Trace the condensate line return from the domestic hot water tank to the vacuum pump.
4. Take note of all valves and fittings on the lines.
5. Make a rough sketch of the system you have just traced. Label all parts and include the direction of flow.

Assignment:

1. Complete a finished sketch of the steam to water cycle.
2. Be prepared to discuss all parts of the cycle with instructor.

ASSIGNMENT 7–A–2

Title: Steam Headers

Objectives:

1. Be able to locate and explain the purpose of the high, medium, and low-pressure steam headers.
2. Be able to locate and explain purpose of the cross connections between the high- and the medium-pressure headers and between the medium- and low-pressure headers.
3. Be able to locate and explain the purpose of all the valves on the high-, medium-, and the low-pressure steam headers.

Apparatus:

High-, medium-, and low-pressure headers and fittings

Procedure:

1. Carefully observe the low-pressure header. Take note of all valves and fittings.
2. In the same manner observe the medium- and high-pressure headers.
3. Carefully observe the cross connections from the high- to the medium- and from the medium- to the low-pressure headers.
4. Take note of all safety devices and record name plate data from safety valves.
5. Make a rough sketch of the steam headers and include cross-over connections, valves, and all lines connected to headers.
   Label all parts and show the direction of flow.

Assignment:

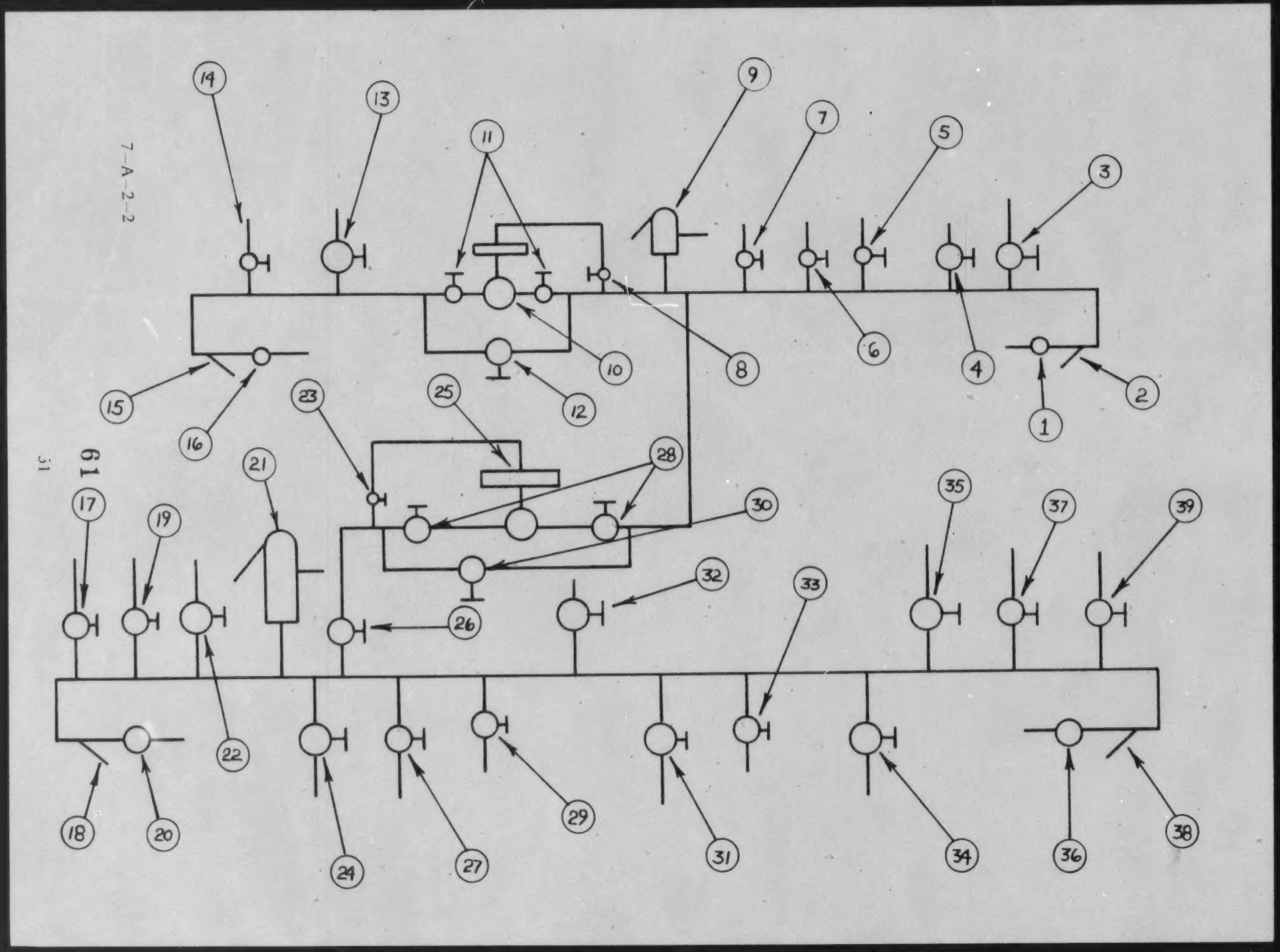
1. Make a finished sketch of the steam headers complete with all lines, fittings, and valves. Label and show direction of flow.
2. Complete attached chart and be prepared to discuss chart and finished sketch with your instructor.

SAFETY VALVE DATA CHART

STEAM HEADERS

DATA	MEDIUM PRESSURE HEADER	LOW PRESSURE HEADER
NAME OR IDENTIFYING TRADE MARK OF MANUF.		
MANUF. DESIGN OR TYPE NUMBER		
INLET PIPE SIZE IN INCHES		
SEAT DIA. IN INCHES		
POPPING PRESSURE POUNDS / SQ. IN.		
BLOW DOWN IN POUNDS / SQ. IN.		
CAPACITY IN LBS. / HR.		
CAPACITY LIFT		
ASME SYMBOL		

7-A-2-1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ASSIGNMENT 7–A–3

Title: Use of the Nipple Chuck

Objectives:

1. Be able to explain purpose of a nipple chuck.
2. Be able to use a nipple chuck.

Apparatus:

Pipe cutting and threading machine
Set of nipple chucks rule
Soap stone
Black iron pipe

Procedure:

1. Show instructor completed safety check-out sheet.
2. Examine nipple chuck and its components.
3. Set up pipe cutting and threading machine and insert nipple chuck.
4. Make up a black iron pipe with a close nipple and one other 6", 5½", 5", or smaller nipple.
5. Clean die head and pipe machine, and return nipple chuck to tool crib.

Assignment:

1. Follow above procedure and have the instructor examine the two pipe nipples that you made.

SAFETY CHECK-OUT LIST

Title: Pipe Machine Check-out List

Student _____ **Date** _____

1. Check over machine and see that there are no tools or rags lying around.
2. Check machine and know proper rotation.
3. Keep rags and loose clothing away from machine when running.
4. Secure pipe before starting machine.
5. Make sure proper die is being used.
6. Do not face the machine to cut threads faster than normal.
7. Do not walk away and leave machine running.
8. Make sure oil is flowing over work while threading.
9. Do not try to stop machine with your hands.
10. Do not check threads by running your finger over threads with machine running.
11. After using machine, clean it and leave it ready for the next man.
12. Always wipe up any oil spills on floor.
13. Wear goggles when using machine.

_____ _____

Student Signature Instructor's Signature

ASSIGNMENT 7–A–4

Title: Pipe Fitting

Objectives:

1. Be able to lay out a pipe fitting job.
2. Be able to complete a pipe fitting job.
3. Be able to test a pipe job for tightness.

Apparatus:

Iron pipe and fittings
Tools
Pipe fitting compound

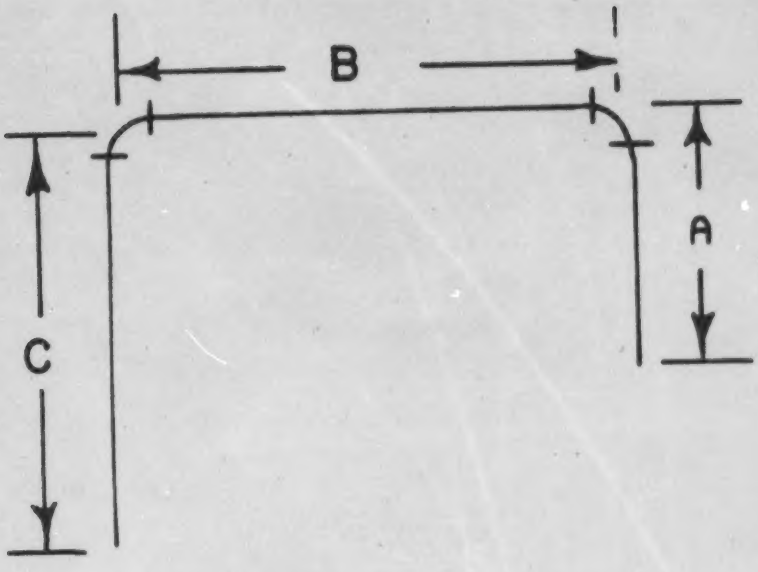
Procedure:

1. Following the attached drawing you will cut, thread, and assemble the pipe and fittings according to your instructor's specifications. All measurements must be exact.
2. After assembling the pipe and fittings, you will connect it to the city water line for testing. It must be tight.

Assignment:

Instructor will examine and test the finished job.

PIPE FITTING LAYOUT



A = _____ END TO END

B = _____ CENTER TO CENTER

C = _____ END TO CENTER

7-A-4-1

ASSIGNMENT 7–B–1

Title: Main Steam Stop and Automatic Non-Return Valves

Objectives:

1. Be able to identify internal parts of a main steam stop valve.
2. Be able to identify internal parts of an automatic non-return valve.
3. Be able to describe how an automatic non-return valve functions.

Apparatus:

Cut-away of a main steam stop valve
Automatic non-return valve
Manufacturers catalog on valves

Procedure:

1. Examine the cut-away of the main steam stop.
2. Take apart, examine, and identify all parts of the valve.
3. Reassemble valve and check for free movement by opening and closing valve several times.
4. Examine the automatic non-return.
5. Dismantle and examine all parts.
6. Identify each part of the valve.
7. Reassemble and check for free movement of all moving parts.
   Note: Instructor is to be notified when each valve is dismantled. Student is to be prepared to identify and discuss the function of each part in the valves with the instructor.

Assignment:

1. Sketch and label a main steam stop valve.
2. Sketch and label an automatic non-return valve showing the direction of flow.

ASSIGNMENT 7–B–2

Title: Pressure Regulators

Objectives:

1. Be able to identify the parts of a pressure regulating valve.
2. Be able to describe how a pressure regulating valve functions.
3. Be able to dismantle a pressure regulating valve.
4. Be able to assemble a pressure regulating valve.
5. Be able to test for proper functioning of a pressure regulating valve.

Apparatus:

Pressure regulating valve tools

Procedure:

1. Dismantle and examine all parts of the regulating valve.
2. Take careful note of the condition of the valve disc, seat, and disphragm.
3. Lay all parts out and identify each part.
4. Notify instructor and be prepared to identify each part and to discuss its function.
5. Assemble the pressure regulating valve; be sure that all parts are in the correct position.
6. Take note of direction of flow through the valve.
7. Connect the proper pressure gages to the air lines; and test for tightness and operating condition of equipment.

   Note: Instructor will be present while you are testing valve.

Assignment:

Be prepared to discuss the following items with the instructor:

1. Parts of the regulator
2. Moving parts of the regulator
3. Parts that are subject to wear
4. How the regulator functions

ASSIGNMENT 7–C–1

Title: Non-Return Traps

Objectives:

1. Be able to describe the function of:
   a. Float
   b. Thermostatic
   c. Inverted bucket
2. Be able to check and service a steam trap.

Apparatus:

Float steam trap
Thermostatic steam trap
Inverted bucket steam trap
Set of tools for dismantling and reassembling

Procedure:

1. Dismantle and examine the float trap taking note of all parts.
2. Reassemble trap.
3. Proceed as in steps one and two, first with the thermostatic trap and then with the inverted bucket trap.
4. Notify instructor and be prepared to discuss the parts and their function in steam traps before assembling each trap.
5. The instructor will assign you a live steam trap which you will secure, remove from the steam line, clean, and repair. Test trap before installing on steam line.

Assignment:

1. Instructor will check trap that you serviced with a pyrometer.
2. Sketch and label all three traps and show direction of flow through each trap.

ASSIGNMENT 9–A–1

Title: Oil Tanks and Piping

Objectives:

1. Be able to change over fuel oil tanks.
2. Be able to transfer fuel oil from one tank to another.

Apparatus:

Fuel oil tanks and piping

Procedure:

1. Examine all piping to and from the fuel oil tanks.
2. Trace the lines, and notice where all stop valves are located.
3. Without closing or opening any valves, simulate changing over the fuel oil tanks. Repeat until you are confident that you can change over tanks.
4. Without closing or opening any valves, simulate change of fuel oil from No. 1 to No.2 tank.
5. After you are sure of being able to transfer oil from No.1 to No. 2 tank, reverse the procedure and pump from No. 2 to No. 1.
   Note: Do not open or close any fuel oil valves.

Assignment:

1. Notify the instructor and be prepared to change over fuel oil tanks. Be able to discuss any item pertaining to changing over the tanks.
2. With the instructor still present, you will transfer fuel oil from No. 1 to No. 2 tank and then reverse the procedure, pumping from No. 2 to No. 1.

ASSIGNMENT 9–A–2

Title: Fuel Oil Pumps and Heaters (Changing Over)

Objectives:

1. Be able to change over fuel oil pumps.
2. Be able to change over fuel oil heaters.

Apparatus:

Fuel oil pumps
Fuel oil heaters

Procedure:

1. Examine all piping valves and fitting connecting the fuel oil pumps and heaters.
2. Trace the path of fuel oil through each pump and heater.
3. Without closing or opening any stop valve, simulate changing over the fuel oil pumps. Remember the pump is a positive displacement pump.
4. Without closing or opening any stop valves, simulate changing over the fuel oil heaters.
   Note: Check the temperature control valve.

Assignment:

1. Notify the instructor and be prepared to change over fuel oil pumps and heaters. Also be prepared to discuss all items pertaining to changing over fuel oil pumps and heaters.

ASSIGNMENT 9–A–3

Title: Gear Pumps

Objectives:

1. Be able to dismantle a gear type pump.
2. Be able to locate and describe the purpose of all internal parts.
3. Be able to reassemble a gear type pump.

Apparatus:

Gear Pump
Tools

Procedure:

1. Mark all parts of the pump before dismantling; this will assist you when reassembling the pump.
2. Dismantle the pump, clean, and lay out all parts.
3. Notify instructor to examine all parts with you. Be prepared to discuss location and purpose of each part.
4. Reassemble the pump making sure that all moving parts are free.

Assignment:

1. Have the instructor inspect the finished pump.

ASSIGNMENT 9–A–4

Title: Pressure Atomizing Burners

Objectives:

1. Be able to disassemble and assemble a pressure atomizing burner.
2. Be able to identify and state the function of all parts of a pressure atomizing burner.
3. Be able to set up, adjust, and fire off a pressure atomizing burner.

Apparatus:

Pressure atomizing burner tools

Procedure:

1. Disassemble all parts of the burner, and mark each part as it is dismantled.
2. Clean and examine all parts.
3. Notify instructor and have him check all parts. Be prepared to discuss the parts and the function of each part.
4. Reassemble the burner and check constantly for free movement of moving parts.
5. Check for the correct electrode setting.
6. Set burner up in location selected by instructor.
7. Prepare burner for operation and for possible adjustments.
8. Notify instructor before firing of burner.
9. Fire off and make necessary adjustments.
10. After a 15-minute run, secure burner.

Assignment:

1. Follow precedure outlined above and notify instructor at the designated times. Be prepared to discuss the operation of the burner with him.

ASSIGNMENT 9–A–5

Title: Rotary Cup Burner

Objective:

1. Be able to disassemble and assemble a rotary cup burner.

Apparatus:

Rotary cup burner
Tools

Procedure:

1. Mark each part of the burner clearly.
2. Disassemble burner, and clean each part as it is dismantled.
3. Lay all the parts of the burner out on the bench.
4. Examine each part for wear or possible damage.
5. Notify instructor and have him check the parts with you.
6. Reassemble the burner. Do not force any parts together, and check for the free movement of all moving parts.

Assignment:

1. Have the instructor inspect the finished burner.
2. Be prepared to discuss the function of the burner, oil flow, and air flow.

ASSIGNMENT 9–A–6

Title: Air Atomizing Burner

Objectives:

1. Be able to identify the parts of an air atomizing burner.
2. Be able to perform routine maintenance on the burner.

Apparatus:

1. Burner on No. 2 boiler

Procedure:

1. Make a one-line drawing of burner No. 2, and show the following:
   a. Burner tube
   b. Oil pump and air compressor
   c. Primary air line
   d. Lubricating oil-air tank
   e. Air pump filter
   f. Modutrol motor
   g. Low-fire adjustment screw – high-fire adjustment screw
   h. Control panel box
   i. Oil solenoid valve
   j. Primary air pressure gage
   k. Primary air adjustment valve
   l. Gas pilot solenoid valve
   m. Lube oil cooler
   n. Oil temperature gage
   o. Air shutter
   p. Fuel oil heater
2. Show the direction of flow of the fuel oil.
3. Check lube oil level in lubricating oil-air tank.
4. Clean air compressor filter.
5. Clean fuel oil strainer.

Assignment:

1. Make a one-line drawing of the No. 2 burner showing parts listed above.
2. Show the direction of flow on the fuel oil drawing.
3. Perform the following maintenance:
   a. Check lube oil level in oil-air tank
   b. Clean air pump filter
   c. Clean fuel oil strainer

ASSIGNMENT 9–C–1

Title: Gas Piping, Valves and Fittings

Objectives:

1. Be able to identify the parts of a solenoid valve.
2. Be able to describe how a solenoid functions.
3. Be able to identify valves and fittings found on a gas line.

Apparatus:

Solenoid valve
Butterfly and slow opening valves, gas cock, and pressure gages on the gas link
Tools and electric tester

Procedure:

1. Disassemble the solenoid and examine all parts.
2. Test coil for continuity.
3. Clean all parts.
4. Assemble solenoid valve and test for operation.
5. Examine the piping, fittings, and valves on No. 3, No. 4, and No. 5 gas lines. Take particular note of the following:
   a. Butterfly valves
   b. Slow opening valve
   c. Main gas cock
   d. Pressure-reducing valve
   e. Pressure gage readings

Assignment:

1. Be prepared to discuss with the instructor the following about solenoid valves:
   a. Purpose of each part
   b. Test for coil continuity
   c. How the valve functions
2. Complete the attached chart and be prepared to discuss all items with your instructor.

GAS LINE FITTINGS

BOILERS	MAIN GAS COCK	PRESSURE REDUCING VALVE	PRESSURE GAUGE READINGS	SLOW OPENING VALVE	BUTTERFLY VALVE
3					
4					
5					

ASSIGNMENT 9–D–1

Title: On–Off Controls

Objective:

1. Be able to adjust the settings on a pressure control, a modulating-pressure control, a vaporstat, and an aquastat.

Apparatus:

1. Pressure-trol
2. Modulating pressure-trol
3. Vaporstat
4. Aquastat
5. Screwdriver
6. Manufacturers data sheets
7. Continuity meter

Procedure:

1. Student will sign out all necessary controls and tools.
2. Take one control at a time; open it up; and with manufacturers data sheets identify all parts.
3. Using data sheets, study how each control works and how it is set.
4. Using continuity meter, test control operation.
5. Student will connect a pressure-trol to air test station and notify instructor. Then explain how he will set control and demonstrate how it works.

Assignment:

1. Follow outlined procedure. NOTE: No testing is to be done without instructor being present.
2. Why is a siphon needed with a pressure–trol and a modulating pressure-trol and not with an aquastat?
3. How does a vaporstat differ from a pressure–trol?
4. What is meant by a built-in range?
5. What is the cut-in and cut-out point of the boiler that is in operation now in our plant?

ASSIGNMENT 9–D–2

Title: Temporary-Pressure Regulator and Relief Valves

Objectives:

1. Be able to identify the parts of a temperature-pressure regulator.
2. Be able to describe how the temperature-pressure regulator functions.
3. Be able to identify the parts of an oil-relief valve.
4. Be able to describe how the oil-relief valve functions.

Apparatus:

Temperature-pressure regulator
Oil-relief valve

Procedure:

1. Disassemble the temperature-pressure regulator; clean and examine all parts as you proceed.
2. Lay out all parts in the order that they are found in the regulator.
3. Have your instructor check your work at this time.
4. Assemble regulator; check for correct movement of parts.
5. Test regulator for correct operation.
6. Disassemble the oil-relief valve.
7. Clean and lay out all parts in order.
8. Have your instructor check your work.
9. Assemble relief valve and test for correct operation.
10. Take note of the location of all oil-relief valves and temperature regulators in the boiler room.

Assignment:

1. Have your instructor examine the regulator and valve.
2. Be prepared to discuss with the instructor the following:
   a. Purpose of each part
   b. How the regulator and relief valve function
3. Complete the attached chart.

LOCATION OF
TEMPERATURE AND PRESSURE REGULATORS

OIL RELIEF VALVES	OIL TEMPERATURE PRESSURE REGULATORS

ASSIGNMENT 9–D–3

Title: Programmer

Objectives:

1. Be able to identify the parts of a programming control.
2. Be able to show where the wires on a terminal block go.
3. Be able to check continuity on one pair of wires.

Apparatus:

1. Fireye programming control
2. Fireye bulletin CP522
3. Continuity meter

Procedure:

1. Student will sign out necessary equipment.
2. Using fireye programmer and data sheet, locate control and check wiring schematic.
3. Trace wires from terminal block to controls.
4. Using data sheet, locate cam assembly, flame relay, master relay, and lockout switch.

Assignment:

1. Follow outlined procedure.
2. Using attached chart, indicate where wires go to from terminal block.
3. With instructor present, identify cam assembly, flame relay, master relay, and lockout switch.
4. Demonstrate how you would test continuity between two points.

TERMINAL BLOCK
FIREYE CONTROL

71

ASSIGNMENT 10–C–1

Title: Combustion Process

Objectives:

1. Be able to describe the combustion process as it takes place in an industrial furnace.
2. Be able to describe the factors that can affect the combustion process.

Apparatus:

Steam boiler in use

Procedure:

1. Watch and listen to instructor during the demonstration.
2. Take notes of important details and of changes that take place in the furnace during the demonstration.
3. The instructor will perform the following operations:
   a. Improper fuel-air ratio
   b. Improper atomization of fuel
   c. Reducing of furnace temperature
   d. Insufficient time for combustion of fuel

Assignment:

1. Complete the attached chart.

COMBUSTION PROCESS

CONDITION	RESULTS	RESULTS	RESULTS
IMPROPER FUEL-AIR RATIO			
IMPROPER ATOMIZATION OF THE FUEL			
REDUCING OF THE FURNACE TEMPERATURE			
INSUFFICIENT TIME FOR COMBUSTION OF THE FUEL			

10-C-1-1

ASSIGNMENT 10–D–1

Title: Fyrite Analyzer

Objectives:

1. Be able to dismantle, clean, recharge and assemble a fyrite CO_2 tester.
2. Be able to use a fyrite CO_2 tester.
3. Be able to interpret CO_2 readings.

Apparatus:

1. Fyrite tester kit
2. Replacement parts kit
3. Data sheet
4. Fresh CO_2 fluid
5. Thermometer

Procedure:

1. Student will sign out all material necessary.
2. Disassemble fyrite tester.
   Note: *Liquid inside is caustic – Do not spill on clothes or yourself. Dispose of liquid in slop sink.*
3. Thoroughly wash all parts with warm soap and water.
4. Examine and replace any defective parts.
5. Using data sheet, identify all parts and the function they perform.
6. Add fresh liquid and reassemble tester.
   Note: *Be careful,liquid is caustic.*
7. Adjust scale to 0.
8. Have instructor check fyrite tester.
9. Read data sheet on how to take CO_2 readings.
10. Explain to instructor how you will use fyrite tester.
11. After instructor has checked you out, go to boiler room. Report to student engineer, and then take CO_2 readings on all boilers on line.
12. Record all readings necessary on chart provided. Report back to lab, and using fyrite chart interpret all necessary data as called for.

Assignment:

1. Follow outlined procedures.
   Note: *Do not allow liquid from fyrite to spill on clothing or on your skin.*
2. Using attached chart, take the following CO_2 reading of all boilers on line:
   2 Readings on high fire
   2 Readings on low fire
3. Have instructor check your readings; then clean up and return your test set.

FYRITE CO_2 TEST CHART

BOILER NO.	HIGH FIRE / LOW FIRE	TYPE FUEL	BOILER ROOM TEMPERATURE	FLUE GAS TEMPERATURE	CO_2 READING	EFFICIENCY / STACK LOSS
1						
2						
3						
4						
5						
6						

10-D-1-1

ASSIGNMENT 10–D–2

Title: Orsat Analyzer

Objectives:

1. Be able to prepare an orsat analyzer for testing boiler flue gas.
2. Be able to set up analyzer in boiler room.
3. Be able to take a flue gas analysis using the orsat.
4. Be able to interpret flue gas readings.

Apparatus:

Data sheets – instructions and parts list for orsat

Procedure:

1. Sign out orsat analyzer and any other necessary material.
2. Read operating instructions.
3. Notify instructor and explain in detail how you would go about taking reading.
4. With instructor present, install orsat analyzer next to the boiler being tested, and take readings on all boilers on line – during high- and low-fire cycle.
5. Record all readings on chart provided.
6. Clean up all test equipment and report back to lab to interpret results.

Assignment:

1. Follow outlined procedure.
2. Record all readings on chart attached.
3. How does the orsat analyzer differ from the fyrite analyzer?
4. Can you see any advantage using an orsat analyzer?
5. How does the fyrite CO_2 reading compare with the orsat CO_2 reading?

ORSAT CO_2 TEST CHART

BOILER NO.	HIGH FIRE / LOW FIRE	TYPE FUEL	BOILER ROOM TEMPERATURE	STACK TEMPERATURE	CO_2	O_2	Co
1							
2							
3							
4							
5							
6							

DO ALL WRITTEN WORK ON BACK.

10-D-2-1

ASSIGNMENT 11–A–1

Title: Differential-Pressure Flow Meter

Objectives:

1. Be able to describe how a differential-pressure flow meter is connected to the line and unit.
2. Be able to blow down the connecting lines.

Apparatus:

1. Differential-pressure flow meter.

Procedure:

1. Trace the lines from the steam flow meter to the orifice plate on the steam line.
2. Take note of how it is connected to the line.
3. Remove the meter from service by closing high- and low-side valves, and then opening by-pass valve.
4. Disconnect both high and low pressure lines from the meter.
5. Blow down each line making sure it is clear. (If unable to clear, notify instructor.)
6. Reconnect lines to meter and wait one hour for condensate to fill lines.
7. Put meter back into service by opening low-pressure valve, closing by-pass valve, and then opening high-pressure valve.
8. Check for possible leaks and correct operation.

Assignment:

After following the above procedure, notify instructor before putting meter back into service.

ASSIGNMENT 11–A–2

Title: Positive Displacement and Variable Area Flow Meters

Objectives:

1. Be able to identify the various parts of a positive displacement meter.
2. Be able to disassemble and assemble a positive displacement meter.
3. Be able to describe how the positive displacement meter functions.
4. Be able to identify the various parts of a variable area meter.
5. Be able to disassemble and assemble a variable area meter.
6. Be able to describe how the variable area meter functions.

Apparatus:

1. Positive displacement meter
2. Variable area meter

Procedure:

1. Examine the positive displacement meter before attempting to disassemble.
2. Mark the parts carefully as you proceed.
3. Disassemble the meter. Clean and examine each part as you do.
4. When the meter is completely apart, cleaned, and laid out on the bench, notify instructor.
5. After examination of parts by the instructor, assemble the meter.
6. Test meter checking for leaks.
7. Repeat the procedure steps No. 1 through No. 6 for the variable area meter.

Assignment:

1. Have instructor check your completed meters.
2. Be prepared to discuss with your instructor the following:
   a. Parts of each meter
   b. How to take each one apart and how to assemble.
   c. How each functions when in service.

ASSIGNMENT 11–B–1

Title: Calibrating of Draft Gages

Objectives:

1. Be able to use a test manometer to test draft gages.
2. Be able to recalibrate draft gages using a test manometer.

Apparatus:

1. Draft manometer
2. Draft test gage

Procedure:

1. Examine each instrument and read directions for use carefully.
2. With each instrument, measure and record the pressure in the furnace of each operating boiler.
3. With each instrument, measure and record the pressure at the breeching of each operating boiler.
4. Make a comparison of the pressure readings on the draft gages and the readings that you recorded with the instruments. How do they compare?
5. Make necessary adjustments on each draft gage.
6. Check for accuracy throughout the range of each gage.
7. Recheck each draft gage with test instrument and record readings.
8. Note any unusual conditions.

Assignment:

1. Complete attached chart showing all data and readings taken.

DRAFT GAUGES

BOILER NO.	BEORE CALIBRATING				AFTER CALIBRATING			
	FURNACE INSTRUMENT	READING GAUGE	BREECHING INSTRUMENT	READING GAUGE	FURNACE INSTRUMENT	READING GUAGE	BREECHING INSTRUMENT	READING GAUGE
1								
2								
3								
4								
5								

11-B-1-1

ASSIGNMENT 11–C–1

Title: Locating and Describing Thermocouples (Review of 10th Grade)

Objectives:

1. Be able to find the location of the thermocouples in our plant.
2. Be able to describe what each thermocouple is recording.

Apparatus:

Thermocouples in boiler room, recorder, pyrometer

Procedure:

1. Identify each thermocouple in the boiler room. Make a list naming the line each thermocouple is attached to and its location on that line. With the pyrometer, measure the temperature at each thermocouple location and record.
2. With recorder running, check your readings against the recorders. Did they compare? If not recheck your readings.

Assignment:

1. Complete attached chart showing all data and readings taken.

THERMOCOUPLE CHART

LOCATION OF	TEMPERATURE WITH PYROMETER	TEMPERATURE ON RECORDER	DIFFERENCE IN READINGS

ASSIGNMENT 11–D–1

Title: Interpreting Recorders

Objectives:

1. Be able to read data from a recorder.
2. Be able to use the integrator reading on flow recorders.
3. Be able to use all data taken from recorders.

Apparatus:

1. Brown Recorder
2. Hay's Recorder

Procedure:

1. While working as the assistant watch engineer for a one-week period you will
   a. Read and record all temperatures from the brown recorder each day.
   b. Read and record steam flow reading.
   c. Read and record steam pressure from recorder.
   d. Read and record integrator reading.
   e. Calculate total steam generated over previous 24 hours.

Assignment:

1. Complete attached chart recording all readings and data taken.

BROWN RECORDER	LOCATION	TEMPERATURE	HAY'S STEAM FLOW RECORDER
UNIT 1			PRESSURE
UNIT 2			
UNIT 3			STEAM FLOW
UNIT 4			
UNIT 5			INTEGRATOR READING
UNIT 6			
UNIT 7			STEAM FLOW PER 24 HOURS
UNIT 8			
UNIT 9			
UNIT 10			

11-D-1-1

ASSIGNMENT 11–E–1

Title: Maintaining Smoke Indicators

Objectives:

1. Be able to clean a haze gage.
2. Be able to check the light source.
3. Be able to change the lamp in the haze gage.

Apparatus:

1. Haze gages in the boiler room.

Procedure:

1. Switch off haze gage at the panel board. Check to see if power is off.
2. Clean lenses at light source and at received end with a clean cloth.
3. Switch haze gage on again, then open receiver cover to check light source.
4. Close cover and check reading at the panel board.
5. To change the lamp in the haze gage, proceed as follows:
   a. Switch off haze gage at the panel board.
   b. Open sending unit in the breeching and remove the old bulb.
   c. Install new bulb and clean lens.
   d. Close unit and switch on the haze gage.
   e. Check receiver for correct light.

Assignment:

1. Clean haze gage each day for one week.
2. Record in the boilerroom log that it was cleaned.
3. If there is any unusual condition with the haze gage, that also should be recorded.
4. Record on the boilerroom log sheet if the light source was changed.

Note: The above can be done when you are assistant engineer for a week.

ASSIGNMENT 12–B–1

Title: Internal Feed-Water Treatment

Objectives:

1. Be able to collect boiler water samples.
2. Be able to test boiler water samples.

Apparatus:

1. Boiler water test cabinet
2. Water sampling bottles
3. Gloves
4. Feed-water test book
5. Feed-water control sheet
6. Feed-water log

Procedure:

1. Student will report to engineer on duty. Under his direction, take a water sample from each boiler that is on line.
2. Use gloves and bottle holder when drawing sample.
3. Blow down line before drawing sample and fill bottle to overflowing and cap it.
4. Bring sample to test kit and let cool.
5. Using instruction on testing boiler water and under the direction of the senior engineering student, run boiler water tests.
6. Log all results and add chemicals if necessary, under the direction of the senior engineering student.

Assignment:

1. Following outlined procedure, draw water samples, run all required tests, and log all results. Add any chemicals if needed, or blow down boiler if tests so indicate.
2. All work will be carried out only after reporting to student engineer on duty and with the senior present who is in charge of feed-water treatment.
3. What are the various tests that have to be run on our boilers?
4. What purpose do these tests serve?
5. Make a copy of your feed-water log and turn it in with this assignment.

ASSIGNMENT 12–C–1

Title: Chemical Control Methods

Objectives:

1. Be able to mix feed-water chemicals.
2. Be able to add chemicals to boiler water.

Apparatus:

1. Feed-water chemicals
2. Chemical buckets
3. Gloves
4. By-pass feeder

Procedure:

1. With senior in charge of feed-water treatment, mix required chemicals.
2. Trace lines and valves on by-pass feeder on the boiler receiving the chemicals.
3. Notify instructor and explain how you would isolate by-pass feeder.
4. Isolate by-pass feeder and chemicals; and place it in service – putting chemicals in boiler.

Assignment:

1. Find where chemicals are stored and know how to identify them.
2. Mix required chemicals; and trace all lines and valves to by-pass feeder.
3. Do not open or close any valves until instructor checks you out.
4. Some chemicals are caustic; always wear gloves and flush off any spills with plenty of cold water.
5. What would happen if you opened top of by-pass feeder before it was isolated from system?
6. Any chemicals added are entered on the log.
7. Sketch by-pass feeder including all valves, and indicate flow.

ASSIGNMENT 12–C–2

Title: Blow-Down Tank

Objectives:

1. Be able to remove blow-down tank from service.
2. Be able to drain and clean blow-down tank.
3. Be able to replace gasket, close up, and put tank back in service.

Apparatus:

1. Bottom blow-down tank
2. New gasket
3. Tools needed to remove manhole cover
4. Brushes and scrappers for cleaning
5. Safety signs

Procedure:

1. Notify engineer on duty that blow-down tank is being taken out of service.
2. Hang safety signs on all boilers on line. (Do not blow down)
3. Dump tank, remove manhole cover, and clean tank.
4. Clean manhole cover and ring on tank.
5. Have instructor inspect before closing up and putting blow-down tank back in service.
6. Notify engineer on duty when tank is ready and back in service.

Assignment:

1. Follow outlined procedures.
2. Why must engineer on duty be notified when blow-down tank is being worked on?
3. Why is it so important to clean manhole cover and ring?
4. How does water leave the blow-down tank and where does it go to?
5. How do you prevent pressure from building up in a blow-down tank?

ASSIGNMENT 13–B–1

Title: Components

Objectives:

1. Be able to trace the compressed air system in our plant.
2. Be able to tie in any compressors we have to our control air system.

Apparatus:

1. All air compressor lines in our plant

Procedure:

1. Trace all air lines from our shop air compressor.
2. Trace all air lines from our main control air compressor.
3. Trace all air lines from our auxiliary control air compressor.
4. Make a sketch showing all air lines, valves, etc. and indicate where they are cross connected.

Assignment:

1. Follow outlined procedure, and turn in a finished labeled sketch.
2. Why do you think it is necessary to have our shop air compressor tied in to our control air system?
3. Complete attached chart showing all pressures indicated.

CONTROL AIR PRESSURE TANK	CONTROL AIR PRESSURE SYSTEM	SHOP AIR PRESSURE TANK	SHOP AIR PRESSURE SYSTEM
CONTROL AIR MAIN: CUT IN / CUT OUT	CONTROL AIR AUXILIARY: CUT IN / CUT OUT	SHOP AIR MAIN: CUT IN / CUT OUT	

13-B-1-1

ASSIGNMENT 13–C–1

Title: Compressor Operation

Objectives:

1. Be able to start and put air compressors on the line.
2. Be able to stop and take air compressors off the line.
3. Be able to blow down compressor tank.
4. Be able to drain compressor tank.
5. Be able to take time checks for proper running conditions.

Apparatus:

1. Shop air compressors
2. Watch for timing

Procedure:

1. Check lubrication oil in compressor.
2. Check for tools or rags.
3. Open discharge valve.
4. Check belts.
5. Start compressor and make sure it cuts off at proper pressure.
6. Open blow-down valve on tank to remove condensate; secure valve when air is blowing.
7. Secure compressor; blow down tank to 0#
8. Start compressor, and record time it takes to build up to 80#'s.

Assignment:

1. Follow outlined procedure on all compressors in shop.
2. Log all required data on chart.
3. When working with main control air compressor, make sure auxiliary compressor is on line.
4. What happens when all control air is dropped to 0# 's in the system?
5. Give all readings to watch engineer for his log.
6. What purpose does an inter cooler serve?

	DATE TAKEN	TIME 0#–80#	DRAIN TANK	OIL LEVEL
CONTROL AIR MAIN				
CONTROL AIR AUX.				
SHOP AIR MAIN				

TIME CHECK FOR RUNNING CONDITIONS.

13-C-1-1

ASSIGNMENT 13–D–1

Title: Compressor Maintenance

Objective:

1. Be able to disassemble, overhaul, reassemble, and test an air compressor.

Apparatus:

1. Air compressor
2. Tools
3. Data sheet

Procedure:

1. Sign out an air compressor.
2. Mark all parts.
3. Strip it clean and replace parts if necessary.
4. Reassemble.

Assignment:

1. Follow outlined procedure.
2. When compressor is completely disassembled and cleaned, notify instructor.
3. Reassemble compressor and set compressor up for test run. Notify instructor.

Note: Keep all parts of compressor together; lost pieces will have to be replaced.

ASSIGNMENT 14–A–1

Title: Electrical Safety

Objective:

1. Be able to use paper safety practices and procedures when working with electrical equipment.

Apparatus:

1. List of electrical safety rules.

Procedure:

1. Study list of safety rules.
2. Do not attempt to work on any electrical assignments until the instructor has discussed safety assignment with you.

Assignment:

1. Can you explain why it is necessary to follow all electrical safety rules?
2. Why do you feel it is necessary to have all electrical equipment grounded?
3. Be prepared to answer any other questions on electrical safety rules.
4. Can you think of any other safety rules to add to our list?

Note: Electrical safety list is to be signed by student and parent and brought back for filing. No electrical assignments can be started unless safety list is on file.

SAFETY ASSIGNMENT ELECTRICAL

1. Always check to see that all power tools are properly grounded.
2. Never use a power tool, extension cord, or drop light with a frayed cord.
3. Never unplug any electrical cord by pulling on wire cord; use plug.
4. Never work on electrical equipment while you or the equipment is standing in water.
5. Do not poke your fingers in electrical switches, starters, or sockets.
6. Do not work on live electric circuits; always pull circuit breaker, fuse, or main switch.
7. Always check electrical equipment with tester after killing circuit to be sure that the power is off.
8. Never pull a fuse by hand; use a fuse puller.
9. Do not work in steam and water side of boiler with a drop light; use a portable light or a low-voltage drop light.
10. Never put current to any project until it has been checked out by the instructor.
11. Do not handle capacitors until they have been discharged.
12. Protect all electrical equipment when washing down.
13. Never use a water extinguisher on an electrical fire.
14. If in doubt, stop and notify instructor.
15. *Don't try to be a live wire; your fuse can not be replaced.*

Any student failing to comply with the above rules may be subjected to dismissal for his own safety as well as the safety of other shop personnel.

Date _____

_____
PARENT'S SIGNATURE

_____
STUDENT'S SIGNATURE

_____
INSTRUCTOR'S SIGNATURE

ASSIGNMENT 14–B–1

Title: Electrical Circuits
(Review of 10th Grade)

Objectives:

1. Be able to lay out a series circuit.
2. Be able to lay out a simple parallel circuit.
3. Be able to lay out a series parallel circuit.

Apparatus:

1. No. 16 insulated wire
2. Two sockets and lights
3. Two switches (single pole)
4. Testing meter
5. Receptacle plug

Procedure:

1. Lay out a series circuit with two lights in the circuit.
2. Lay out a parallel circuit with two lights in parallel, and a switch in series with each light. Check each circuit with the meter.

Note: Before any tests are made, student will have instructor check all wiring.

Assignment:

1. After laying out each circuit, instructor will check finished work.
2. Be prepared to discuss the laying out of each circuit with your instructor.

ASSIGNMENT 14–B–2

Title: Basic Burner Control Circuit

Objective:

1. Be able to describe how the pressure-trol, aquastat and the low-water cutoff are connected in a burner control circuit.

Apparatus:

1. No. 16 insulated wire
2. Pressure-trol and aquastat
3. Low water cut-off
4. Lamp and socket
5. Test meter for continuity

Procedure:

1. Make a line drawing on sketch paper of how you are going to connect the pressure-trol, low-water cutoff, aquastat, and lamp in a series circuit.

   Note: Instructor must approve drawing before proceeding.
2. Connect in series the following controls:
   a. Pressure-trol
   b. Aquastat
   c. Low-water cutoff
   d. Lamp and socket
3. Test circuit for continuity, grounds, and shorts.
4. Notify instructor when ready to connect to a power source.

Assignment:

1. Connect circuit to a power source and check to see that each control functions properly.
2. Be prepared to discuss the following with your instructor.
   a. The function of the pressure-trol in the circuit.
   b. The function of the aquastat in the circuit.
   c. The function of the low-water cutoff in the circuit.
   d. The possibility of connecting one or all of the above controls in a parallel circuit.

ASSIGNMENT 14–C–1

Title: Starters, Relays, and Switches

Objectives:

1. Be able to disassemble, clean the contacts, and assemble a motor starter.
2. Be able to clean relays and switches.

Apparatus:

1. Motor starter
2. Relay
3. Switch

Procedure:

1. Disassemble and clean the motor starter.
2. Examine contacts and dress with a contact file if they are worn.
3. Assemble starter and test.
4. Disassemble and clean the relay.
5. Dress the contacts if necessary.
6. Assemble relay and test.
7. Examine switch, clean, and dress contacts.

Assignment:

1. Have instructor check your work after the following:
   a. When starter is disassembled, cleaned, and contacts are OK.
   b. When starter is ready for testing.
   c. When relay is disassembled, cleaned, and contacts dressed.
   d. When relay is ready for testing.
   e. When the switch is cleaned.

ASSIGNMENT 14–C–2

Title: Fuses, Breakers, and Heaters

Objectives:

1. Be able to test fuses and breakers.
2. Be able to replace a fuse.
3. Be able to replace a heater.

Apparatus:

1. Assorted fuses, breakers, and heaters
2. Motor starter
3. Fuse pullers
4. Fuse box
5. Test meter

Procedure:

1. Test each fuse and breaker for continuity.
2. Check each cartridge fuse to see how to replace link.
3. Using the fuse puller, pull fuses from the fuse box and check for continuity.
4. Replace fuses with the fuse puller.
5. Remove the heaters from the motor starter, and check heater numbers to see if they correspond with the number recommended for that starter.
6. Replace heaters in the starter, and test.

Assignment:

1. After completing the above procedure, notify instructor and be prepared to answer the following:
   a. How a fuse is tested.
   b. How to replace a fuse.
   c. How to test a breaker.
   d. How to replace a heater.

ASSIGNMENT 14–D–1

Title: Types and Uses of Meters

Objectives:

1. Be able to describe the various types of electrical meters.
2. Be able to show how to use the various types of electrical meters.

Apparatus:

1. Voltage meter
2. Ampmeter
3. Ohmmeter
4. Continuity meter
5. Motor

Procedure:

1. Examine each meter carefully taking note of the use for each meter.
2. Disassemble the motor, marking each part where necessary.
3. Check the motor windings with the continuity and the ohmmeters; record all readings.
4. Assemble the motor, and connect to a power source.
5. Check voltage at the motor with voltmeter, and record.
6. With motor running check load with the ampmeter, and record.

Assignment:

1. Complete the attached chart.
2. Have instructor check motor.
3. Be prepared to discuss the types and uses of the various meters with the instructor.

TESTING FOR	1st. READINGS	2nd. READING	3rd. READING
CONTINUITY			
RESISTANCE			
VOLTAGE			
AMPERAGE			

14-D-11

ASSIGNMENT 15–A–1

Title: Taking Over and Maintaining a Shift

Objectives:

1. Be able to take over a shift.
2. Be able to maintain a shift.

Apparatus:

1. Boilerroom
2. Boilerroom log
3. Student fireman responsibility list

Procedure:

1. Study student fireman responsibility sheet.
2. Notify instructor when ready; then follow routing of taking over a shift with the instructor.
3. Proceed with normal duties of maintaining a shift.

Assignment:

1. Follow outlined procedure above.
2. You will be assigned the duties of a fireman on a weekly basis throughout the year.
3. Why do you think it is necessary to report for work 15 to 20 minutes early?
4. If you had been on shift for 30 minutes and a pump burns up, who is to blame?

ASSIGNMENT 15–A–2

Title: Assisting in Plant Start-Up and Shut-Down

Objectives:

1. Be able to help start up a dead plant.
2. Be able to help secure a live plant.

Apparatus:

1. Boilerroom

Procedure:

1. With the senior engineering student, check complete plant for start-up conditions.
2. Assist in inspecting and starting all necessary auxiliary equipment.
3. Assist in starting boiler and help perform all safety checks.
4. With senior engineering student, help secure the plant so that it will be left in a safe condition.

Assignment:

1. Follow procedure outlined above.
2. Make a detailed list of step-by-step procedure to follow in starting up a dead plant.
3. Make a detailed list of the step-by-step procedure in securing a live plant.

ASSIGNMENT 15–A–3

Title: Fuel Change Over

Objective:

1. Be able to change burner over from gas to oil or oil to gas.

Apparatus:

1. Combination burner gas or oil
2. Data sheet

Procedure:

1. Examine boiler #3 burner, controls, and piping.
2. Examine boiler #4 burner, controls, and piping.

Assignment:

1. With the help of burner data sheets, make a sketch of gas and oil piping including all valves needed to change over for both #3 and #4 boilers.
2. Notify instructor when ready, and describe in detail how you would go about changing over.
3. Pick one boiler, and actually change it over.

ASSIGNMENT 15–B–1

Title: Draft Adjustments

Objectives:

1. Be able to adjust furnace draft for automatic operation.
2. Be able to adjust furnace draft for manual operation.

Apparatus:

1. Boilerroom

Procedure:

Note: *Student engineer must be on hand while completing this assignment.*

1. Examine condition of fire in Boiler #1.
2. Record draft reading on gage.
3. Open manual damper wide.
4. Examine fire and record draft reading.
5. Gradually close damper taking note of fire and draft reading on gage.

Note: Do not let reading on draft gage get closer to zero than -.05".

6. Reset damper to original position.
7. Examine condition of fire on Boiler #3.
8. Follow the same procedure, but use damper control setting at panel board.

Assignment:

1. Enter all data called for on attached chart.
2. Why is it important to control the furnace draft?
3. In your opinion, which of the draft systems (manual or automatic) would be more effective in maintaining a clean fire? Why?

BOILER 1

BOILER 3

DAMPER POSITION	HIGH OR LOW FIRE	DRAFT READING FURNACE	DRAFT READING UP TAKE	CONDITION OF FIRE	TYPE OF FUEL

15-B-H

ASSIGNMENT 15–B–2

Title: Oil and Gas Adjustments

Objectives:

1. Be able to describe where various oil and gas adjustments can be made that will affect operating conditions.
2. Be able to describe how these adjustments affect operating conditions.

Apparatus:

1. Boilerroom
2. Charts attached

Procedure:

1. Start where fuel oil lines enter boilerroom, and indicate on chart all the temperature and pressure adjustments possible.
2. Inspect each boiler, and indicate all possible temperature or pressure adjustments on oil or gas lines.

Assignment:

1. Follow procedure outlined above.
2. Record all temperatures, pressures, and effects indicated.
3. Why do you think it is necessary to be able to adjust temperatures and pressures in the system? Why can't they be fixed at one point?

Note: Following is example of How To Use Chart:

Location of adjustment	Fuel oil suction line
Type of adjustment	Temperature
Reading Temp.-Press.	100°F
Effect if too high	Fuel oil pump may lose suction – fires will be unstable
Effect if too low	Fuel pump will growl – suction press will increase

You must indicate at least 10 points of adjustment in our system.

LOCATION OF ADJUSTMENT	TYPE OF ADJUSTMENT TEMP. PRESS.	READING TEMP. PRESS.	EFFECT IF TOO HIGH	EFFECT IF TOO LOW

15-B-2-1

ASSIGNMENT 15–C–1

Title: High- or Low-Water Condition

Objective:

1. Be able to handle high- or low-water conditions.

Apparatus:

1. Boilerroom – boiler on line

Procedure:

1. Report to student engineer and explain your assignment.
2. Ask him to allow water level in boiler to drop slowly. Notice what happens.
3. Bring water level up to normal, and then slowly add water to about 1" from top of glass. Notice what happens.
4. Using bottom blow-down, restore water to proper level.

Assignment:

1. Follow outlined procedure above.
2. What effect did dropping the water level in the boiler have?
3. How much water was in the gage glass at that point?
4. What effect did adding water to 1" from top of glass have?
5. What is the danger of high water? Low water?
6. How do you know when it is still safe to add water to your boiler?
7. If you entered your boiler room and saw no water in your gage glass and got no water out of bottom try cock, what would you do?
8. If you entered your boiler room and saw a full glass of water, what procedure would you follow?

ASSIGNMENT 15–C–2

Title: Flame Failure

Objectives:

1. Be able to recognize when boiler has had a flame failure.
2. Be able to put boiler back in service after a flame failure.

Apparatus:

1. Boilerroom – boiler on line
2. Watch for timing

Procedure:

1. Report to student engineer and explain your assignment.
2. Ask him to remove fireye from boiler on line. Notice what happens and the amount of time that it took.
3. Ask him to reset control; then time how long it takes for burner to light off.

Assignment:

1. How long did it take for fireye to shut burner off?
2. Explain how to reset your control.
3. How long after reset before pilot lights?
4. How long after pilot lights does main flame come on?
5. How can you tell if boiler is off on a flame failure, and what procedure would you follow before lighting off?

ASSIGNMENT 16–A–1

Title: Cleaning Fire Side

Objectives:

1. Be able to use mechanical boiler cleaning tools.
2. Be able to clean furnace and tubes in a fire-tube boiler.

Apparatus:

1. Boiler cleaning tools (air or electric)
2. Scaffold
3. Gloves, mask, and goggles
4. Wire brushes
5. Vacuum
6. Boiler to be cleaned

Procedure:

1. You will be assigned a boiler that is off the line and cool.
2. Lock out all controls.
3. Hang signs – "Danger – man in boiler".
4. Set up scaffold.
5. Set up cleaning tools.
6. Open up fireside of boiler; secure firedoors carefully.
7. Use drop cloths to protect burner.
8. Punch tubes; then wire brush tube sheets, furnace, and combustion chamber.
9. Use vacuum to pick up all soot.
10. Clean up all soot around outside of burner.
11. Have instructor check your work; then close up boiler.
12. Clean all boiler tools and store them neatly.

Assignment:

1. Follow procedure outlined above.
2. Why do you think it is necessary to remove all signs of soot – especially if you were laying up your boiler.

ASSIGNMENT 16–A–2

Title: Cleaning Water Side

Objectives:

1. Be able to remove, clean, and replace handhole and manhole covers.
2. Be able to thoroughly clean the water side of a firetube boiler.

Apparatus:

1. Manhole and handhole gaskets
2. Boiler to be cleaned
3. Hose for flushing
4. Bucket

Procedure:

1. You will be assigned a boiler that is off the line and cool.
2. Lock out all controls.
3. Hang sign "Danger – Man in Boiler"
4. Make sure that top try cock or air cock is open.
5. Remove manhole cover taking care that cover or nuts do not drop in boiler.
6. Take cover, dogs, bolts, and nuts to work bench.
7. Remove gasket from manhole cover, and thoroughly clean cover.
8. Chase threads on bolts and nuts.
9. Thoroughly clean inside of boiler where manhole cover seats.
10. Using bottom blow-down valves, dump boiler.
11. Secure and tag out bottom blow-down valves.
12. Remove all handhole plates, and thoroughly flush water side.
13. Get new gaskets for manhole and handhole, soak gaskets in bucket of water.
14. Follow same procedure for cleaning handholes as you did for the manhole.
15. When water side is thoroughly clean, notify instructor for check out.
16. When putting handhole and manhole covers back, make sure gaskets line up even all around.
17. Have instructor check before refilling boiler.

Note: Never dump a boiler that is hot. Never dump a boiler unless you intend to flush it at once.

Assignment:

1. Follow procedure outlined above. Be prepared to answer the following questions.
2. Why is it important to clean both manhole and handhole covers? Why is it important to clean where the covers seat in boiler?
3. Why is it necessary to vent the boiler before opening steam or water side?
4. Why are handhole and manhole covers oval instead of round?
5. Do you think old gaskets can be used again? Explain.

ASSIGNMENT 16–A–3

Title: Boiler Inspection

Objectives:

1. Be able to assist in getting a boiler ready for inspection.
2. Be able to remove and replace a fusible plug.
3. Be able to locate and remove all plugged tees.
4. Be able to assist in removing tops of feed-water regulators for cleaning and internal inspection.

Apparatus:

1. Boiler
2. Fusible plug
3. Rope
4. Teflon tape

Procedure:

1. Secure boiler; then thoroughly clean both fire and water side. Remove and clean all handholes and the manhole cover.
2. Locate and remove old fusible plug; replace with a new one.
3. Locate and remove all plugs on cross tees; clean plugs and wrap threads with teflon tape.
4. Remove tops of all feed-water regulators and low-water cutoffs.
5. Remove float from inside regulator; and using rope, lash top of regulator and float out of the way.
   Note: Do not bend float rod, and do not disturb any wiring.
6. Chase threads on bolts and bolt holes.
7. Thoroughly clean inside of regulator.
8. Make a new gasket for regulator, and keep all parts together ready for reassembly.

Assignment:

1. You will follow the procedure outlined above working with and under the direction of a senior engineering student.
2. When boiler is ready, he will notify the instructor in charge. After the instructor's examination, the boiler inspector will be called in.
3. When the inspector arrives, you and the senior engineering student will assist him with the inspection. Make notes of any information that he gives you.
4. After inspection, you will ask the instructor in charge whether the boiler is to be put back in service or layed up.

ASSIGNMENT 16–A–4

Title: Laying Up a Boiler

Objective:

1. Be able to assist in laying up a boiler – wet or dry.

Apparatus:

1. Boiler (firetube)
2. Gaskets, manhole and handhole

Note: Boilers that have just passed inspection will either be closed up to be put back into service or layed up. Instructor in charge will decide whether boiler will be layed up wet or dry.

Procedure:

To lay up a boiler wet:

1. Thoroughly clean fire side, water side, handhole covers, and manhole covers, and seats.
2. Examine water side to be sure there are no tools, rags, or personnel inside. Then close it up using new gaskets.
3. Fill boiler with chemically treated water. Chemicals to be supplied by senior engineering student in charge of feed-water treatment.
4. When water comes out the air cock, secure water to boiler.
5. Oil down firebox, tube sheets, and tubes.
6. Close all dampers and hang signs.

To lay up a boiler dry:

1. Follow procedure outlined for cleaning fire side and water side.
2. Oil down firebox, tube sheets, and tubes.
3. Place manhole and handholes together in firebox.
4. Close all dampers and hang signs.

Note: In a damp boiler room, it would be better to close steam and water side of boiler leaving trays of water absorbing chemicals inside (slaked lime or silica-gel). These chemicals would have to be checked periodically and replaced when they become water logged.

Assignment:

1. You will follow the procedure outlined above working with and under the direction of a senior engineering student.

ASSIGNMENT 16–A–5

Title: Replacing Gage Glass

Objectives:

1. Be able to describe how the internal parts of gage glass fittings are constructed.
2. Be able to measure and cut a gage glass to size.

Apparatus:

1. Gage glass cutter
2. Gage glass
3. Gage glass washers
4. Model of gage glass fittings

Procedure:

1. Examine model of gage glass with fittings, and take note of the internal parts.
2. Examine gage glass cutter.
3. Measure the inside dimensions of the gage glass fittings; then subtract from it to give you the size gage glass needed.
4. Measure and cut to the correct length the gage glass needed.
5. Install the gage glass you have just cut using new washers.
6. Tighten gage glass nuts as per instructor's instructions.

Note: Do not tighten too much or the glass will break.

Assignment:

1. Follow procedure as outlined above.
2. Have your instructor examine completed work.
3. Be prepared to discuss any or all of the above procedures with your instructor.

ASSIGNMENT 16–B–1

Title: Rotary Cup Burner

Objective:

1. Be able to perform routine service and maintenance on a rotary cup burner.

Apparatus:

1. Rotary cup burner

Procedure:

1. Secure burner; then check with instructor before proceeding.
2. Mark fan housing cover, and remove it.
3. Clean the fan and housing making sure that the line to the air switch is open and also check to see if the primary air damper is clean.
4. Remove the burner cup, and clean it taking care not to damage the parts.
5. Remove the oil solenoid valve and the burner tube.
6. Clean the solenoid valve and the burner tube.
7. Check the belts and pulleys for wear. Replace if needed.
8. Replace burner tube and solenoid valve using a new gasket.
9. Replace the burner cup.
10. Replace the fan housing, and check for the correct alignment.
11. Check for correct operation of the air switch.

Assignment:

1. Follow the above procedure; check with instructor after steps 1 and 7.
2. The instructor will examine completed work.
3. Be prepared to answer all questions pertaining to the routine maintenance of a rotary cup burner.

ASSIGNMENT 16–B–2

Title: Air Atomizing Burner

Objectives:

1. Be able to clean the burner assembly on an air atomizing burner.
2. Be able to clean the air filter on an air atomizing burner.

Apparatus:

1. Air atomizing burner

Procedure:

1. Secure burner; notify instructor before proceeding.
2. Disconnect oil and gas lines.
3. Remove bolts connecting burner assembly to fan housing.
4. Remove burner assembly; carefully disconnect wiring to the electrodes.
5. Clean the burner assembly housing.
6. Clean the burner assembly.
7. Check the electrodes for the proper clearances. Reset electrodes if clearance is incorrect.
8. Replace burner assembly, connecting electrodes as the burner assembly is being inserted into the housing.
9. Replace bolts in cover.
10. Connect oil and gas lines to the burner assembly.
11. Remove and clean air filter to the air compressor.
12. Renew oil in the filter and replace filter element.
13. Clean outside of burner completely.

Assignment:

1. Follow the above procedure, and notify instructor if you have any problems.
2. Be prepared to discuss all phases of the removal, cleaning, and assembling of the burner assembly.

ASSIGNMENT 16–B–3

Title: Gas Burner

Objective:

1. Be able to clean the blower and butterfly valve on a gas burner.

Apparatus:

1. Gas burner

Procedure:

1. Secure burner; have instructor check power supply before proceeding.
2. Remove the blower from its housing.
3. Clean the blower and the blower housing.
4. Replace blower; check for correct movement.
5. Clean and check for free movement of the butterfly valve.
6. Clean complete burner.

Assignment:

1. Follow the above procedure and have your instructor inspect the finished work.
2. Be prepared to discuss all phases of the removal, cleaning, and assembling of the blower and the butterfly valve.

ASSIGNMENT 16–C–2

Title: Valve-Stem Packing

Objectives:

1. Be able to measure the valve-stem packing.
2. Be able to cut the valve-stem packing.
3. Be able to pack a valve stem.

Apparatus:

1. Valve
2. Valve-stem packing

Procedure:

1. You will be assigned a valve to pack.
2. Secure valve so that it is safe to repack.
3. Remove packing gland nuts, and slide gland back to expose old packing. Chase threads if needed.
4. Remove all old packing from the packing box. (Check for any small particles.)
5. Clean stem of valve with crocus cloth or cleaning fluid.
6. Take the inside and outside measurement of the gland.
7. To determine packing size, calculate:

$$\frac{\text{Outside} - \text{Inside}}{2} = \text{Packing Size}$$

8. Using the correct type and size packing, cut the required number of rings needed for the valve.
   Note: Each ring must butt after going around the valve stem.
9. Insert first ring with the opening at the top; then successive rings are 120° apart in a clockwise direction.
10. Replace gland and nuts. Insert gland at least 1/8".

Assignment:

1. Ask the instructor to check your work after you have secured the valve.
2. Be prepared to discuss how you are going to remove old packing to take measurements and to repack the valve.
3. Instructor will inspect the completed valve.

ASSIGNMENT 16–C–2

Title: Sump Pump

Objective:

1. Be able to assist in the routine maintenance of a sump pump.

Apparatus:

1. Sump pumps in the boilerroom

Procedure:

1. You will assist a senior engineering student in the servicing of an assigned sump pump.
2. Check to make sure all power has been disconnected from the pump.
3. You will assist in disconnecting the electrical and piping connections from the pump.
4. Set up the hoist and the necessary slings to raise the pump.
5. Remove hold-down bolts from sump.
6. Raise pump slowly, checking to see if all connections have separated properly.
7. Raise pump; then lower it onto the space provided on the floor.
8. Clean pump completely.
9. Check the following after the pump has been cleaned.
   a. Lubrication fittings and lines
   b. Bearings for wear and free movement
   c. Impeller for wear, free movement, or rubbing
   d. Casing for gaskets and broken bolts
10. Pump has to be examined by the instructor at this point.
11. Replace pump taking care not to damage lines or fittings.
12. Reconnect electrical and piping connections to the pump.
13. Test run pump with the instructor present.

Assignment:

1. You will follow the procedure outlined above working with and under the direction of a senior engineering student.